

COMPREHENSIVE TECHNICAL REPORT OF THE INQUIRY  
INTO THE APPLICATION OF LIVING SYSTEMS THEORY  
TO 41 U. S. ARMY BATTALIONS:  
EXECUTIVE SUMMARY

Gordon C. Ruscoe  
University of Louisville

James S. Cary  
Department of the Army

Glenda Y. Nogami, Contracting Officer's Representative

Submitted by

T. Owen Jacobs, Chief  
LEADERSHIP AND MANAGEMENT TECHNICAL AREA

and

Joyce L. Shields, Director  
MANPOWER AND PERSONNEL RESEARCH LABORATORY



U. S. Army

Research Institute for the Behavioral and Social Sciences

November 1984

Approved for public release; distribution unlimited.

This report, as submitted by the contractor, has been cleared for release to Defense Technical Information Center (DTIC) to comply with regulatory requirements. It has been given no primary distribution other than to DTIC and will be available only through DTIC or other reference services such as the National Technical Information Service (NTIS). The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other official documentation.

84 11 30 016

①

AD-A148 156

FILE COPY

DEC 3 1984  
A

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM	
1. REPORT NUMBER Research Note 84-132	2. GOVT ACCESSION NO. AD-A148156	3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle) Comprehensive Technical Report of the Inquiry into the Application of Living Systems Theory to 41 U. S. Army Battalions.- Executive Summary, Volume 1 of 3		5. TYPE OF REPORT & PERIOD COVERED Research Note	
		6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s) Ruscoe, Gordon C., Ph.D., University of Louisville Cary, James S., MAJ, Department of the Army		6. CONTRACT OR GRANT NUMBER(s) DABT 60-80-C-0021	
9. PERFORMING ORGANIZATION NAME AND ADDRESS University of Louisville, Louisville, KY 40208		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS  2Q263743A791	
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Research Institute for the Behavioral & Social Sciences, 5001 Eisenhower Avenue Alexandria, VA 22333-5600		12. REPORT DATE November 1984	
		13. NUMBER OF PAGES 65	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report)  UNCLASSIFIED	
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE	
16. DISTRIBUTION STATEMENT (of this Report)  Approved for public release; distribution unlimited.			
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)			
18. SUPPLEMENTARY NOTES			
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Systems Science Living Systems Theory Battalion Effectiveness Organizational Effectiveness			
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This is volume one, executive summary, of a three volume set of reports. It describes approximately three years of research with U.S. Army Battalions, using an approach based on Miller's Living Systems Theory. The text describes general systems science, living systems theory, and the research that was done. Among the specific findings are the following. For training time, good battalions differed from less good ones not in the total amount of time spent, but in how it was spent. Three information processing variables related to battalion			

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

1 SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)



• • • • •

1

# COMPREHENSIVE TECHNICAL REPORT OF THE INQUIRY INTO THE APPLICATION OF LIVING SYSTEMS THEORY TO 41 U. S. ARMY BATTALIONS

## EXECUTIVE SUMMARY VOLUME 1 of 3

---

### Authors

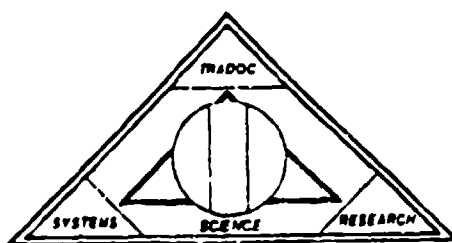
---

#### Department of the Army

MAJ James S. Cary  
CPT Bradford G. Loo  
CPT Robert W. Reed  
CPT Mark L. Sturm  
Billy L. Burnside, Ph.D.  
SFC William T. Leftridge

#### University of Louisville

Gordon C. Ruscoe, Ph.D.  
Bill R. Brown, Ph.D.  
Robert Fell  
Kenneth T. Hunt, Ph.D.  
Yos Kimsawatde  
Steven L. Merker, Ph.D.  
Lorena R. Peter, Ph.D.  
Kathleen Quinkert  
Gerhard Rauchfuss



United States Army  
Soldier Support Center  
P.O. Benjamin Harrison, OH



U. S. Army Research Institute  
Alexandria, VA



Systems Science Institute  
University of Louisville  
Louisville, KY

## ABSTRACT

This three volume technical report presents the methodology and findings of studies, using the Living Systems Process Analysis, of forty-one U.S. Army battalions.

Volume I contains an executive summary of the approximately three years of research conducted on U.S. Army battalions. Included in the text is a discussion of General Systems Science and Living Systems Theory. The scope/goals, methodology, findings, and summary of the two distinct phases of the research (Phase I and Phase II) constitute most of this volume. The Norms Study, conducted to obtain information from the Phase II research data to create normative tables for potential pathology determination, is also included. A brief description of the conclusions, implications, and future applications of the research studies is the closing section in Volume I.

Volume II is divided into two major sections. Section I reports the scope/goals, methodology, analysis, and findings of the Phase I research. This research was conducted from August 1978 to December 1979 as a pilot project to apply the Living Systems information processing concepts to an analysis of the training management activities of six armor battalions. As a result of the research conducted in this pilot project, indications of the potential descriptive and diagnostic utility of Living Systems as a research technique emerged, and the Living Systems Process Analysis (LSPA) was developed to analyze U.S. Army battalions in future research initiatives and LSPA was demonstrated in the Phase II research (August 1978 -December 1979). The detailed discussion of the scope/goals, methodology, analysis, and findings of this research phase is the second section of Volume II. This research was a broadened version of the Phase I project. The management of the training, personnel, and logistics activities of 35 U.S. Army battalions (combat, combat support, and combat service support) from FORSCOM and USAREUR was analyzed using the Living Systems concepts for information and materiel processing. The findings affirmed the conclusions of the Phase I research and also demonstrated that all battalions concentrate their efforts on the information rather than materiel processes and that unit effectiveness is strongly related to the efficient execution of the information processes. Further, the effectiveness of a unit is related to a clear functional division of labor as evidenced by distinctive differences in the distribution of time and effort expended by unit members in performing of the processes.

Volume III contains a copy of all the data collection instruments used in the Phase I and Phase II research. These instruments are referenced throughout the discussions in Volume II and are indexed by phases accordingly.

# VOLUME I

## TABLE OF CONTENTS

	<u>Page</u>
List of Tables . . . . .	ix
List of Figures . . . . .	x
I. Introduction . . . . .	1
A. Background . . . . .	1
B. General Systems Science . . . . .	1
C. Living Systems Theory . . . . .	2
D. Living Systems in Army Vernacular . . . . .	4
II. Research . . . . .	5
A. Phase I . . . . .	5
1. Scope/Goals. . . . .	5
2. Methodology . . . . .	5
3. Findings . . . . .	6
4. Summary . . . . .	10
B. Phase II . . . . .	11
1. Scope/Goals . . . . .	11
2. Methodology . . . . .	11
3. Findings . . . . .	14
4. Summary . . . . .	18
C. Norms Study . . . . .	19
1. Scope/Goals . . . . .	19
2. Methodology . . . . .	21
3. Findings . . . . .	21
4. Summary . . . . .	24
III. Conclusions and Implications . . . . .	25
A. Introduction . . . . .	25
B. Implications - Descriptive Utility . . . . .	27
C. Diagnostic Utility of LSPA . . . . .	28
D. Further Implications . . . . .	28

	<u>Page</u>
IV. Future Applications . . . . .	34
A. Battalion Systems Analysis Package (BSAP) . . . . .	34
B. Living Systems Process Analysis in Simulated Combat Environments (LSPA-Field) . . . . .	34
C. Command and Control (C <sup>2</sup> ). . . . .	34
D. Modeling. . . . .	35
E. Living Systems Based Course of Instruction (COI). . . . .	35
F. Reconceptualizing the U.S. Army Organization Using a Living Systems Approach. . . . .	35
Bibliography . . . . .	54

# List of Tables

	<u>Page</u>
Table 1. The 19 Critical Subsystems of a Living System. . . . .	3
Table 2. Process Definitions. . . . .	12



## List of Figures

	<u>Page</u>
Figure 1. Seven Levels of Living Systems . . . . .	36
Figure 2. Inputs, Throughputs, and Outputs . . . . .	36
Figure 3. 19 Critical Processes. . . . .	37
Figure 4. Armor Battalion Task Force and Trains. . . . .	37
Figure 5. System Performance: Lag in Processing Tng Mgt Info. . . . .	38
Figure 6. System Performance: Information Lag - Tng Mgt Activities. . . . .	38
Figure 7. System Performance: Lag in Processing Tng Mgt Info . . . . .	39
Figure 8. System Performance: Distortion in Processing Tng Mgt Info . . . . .	39
Figure 9. System Performance: Cost in Processing Tng Mgt Info . . . . .	40
Figure 10. System Performance: Cost of Processing Tng Mgt Info . . . . .	40
Figure 11. System Performance: Perceptions of Process Efficiency . . . . .	41
Figure 12. System Performance: Total Cost of Processing Tng Mgt Info by Components . . . . .	41
Figure 13. System Performance: Subsystem Cost by Component . . . . .	42
Figure 14. General Findings . . . . .	42
Figure 15. Conceptual Model . . . . .	43
Figure 16. Units Base for Data Collection . . . . .	43
Figure 17. Breakout of Data Sample Respondents. . . . .	44
Figure 18. Battalion Effectiveness Ranks (BERs) . . . . .	44
Figure 19. Process Perception Data. . . . .	45
Figure 20. Process Objective Data . . . . .	45
Figure 21. Process Objective Data/Process Perception Data Relationship . . . . .	46
Figure 22. Data Matrix. . . . .	46
Figure 23. Training Management Information/Armor Battalions . . . . .	47
Figure 24. Percentage of Total Duty Time in Personnel . . . . .	47

	<u>Page</u>
Figure 25. Percentage of Total Duty Time in Logistics . . . . .	48
Figure 26. Percentage of Total Duty Time in Training - Overall and S-3 Section. . . . .	48
Figure 27. Percentage of Total Duty Time in Training - Bn CDRs, S-3 Sections and Co CDRs . . . . .	49
Figure 28. Percentage of Total Duty Time in Training - S-3 Section by Component. . . . .	49
Figure 29. Percentage of Total Duty Time in Training - Information Inputting and Circulating. . . . .	50
Figure 30. Training Performance and Battalion Effectiveness: Major Processes. . . . .	50
Figure 31. Training Performance and Battalion Effectiveness: Contributing Process . . . . .	51
Figure 32. Training Performance and Battalion Effectiveness: Complete Training Model. . . . .	51
Figure 33. Performance Indicator Scale: Sample . . . . .	52
Figure 34. Performance Indicator Scale: IT Accuracy in Training. . . . .	52
Figure 35. Performance Indicator Scale: IT Time in Training. . . . .	53

#### DISCLAIMER

The information in this report does not represent an official Department of the Army position unless so designated by other authorized documents issued and approved by the Department of the Army. The contents of this report may not be cited for purposes of advertisement.

#### NOTE

The research described herein is the culmination of several years of work by many individuals from both the military and civilian communities. Thus, to give credit to each for all contributions is not possible. However, it is hoped that the Bibliography presented offers proper credit.

## INTRODUCTION

### Background

In 1978 the Battlefield Development Plan and other net assessment initiatives revealed a series of startling problems concerning Army units' ability to accomplish assigned missions. Thus in 1978 the Commanding General (CG), United States Army Training and Doctrine Command (HQ TRADOC), established the Systems Doctrine Office to begin conceptualizing solutions to these newly identified and very serious problems. This office, the nucleus for Task Force Delta (Delta Force), undertook a search of scientific technology in hopes of isolating an innovative technique which could be utilized to meet the challenges imposed by the problem.

### General Systems Science

The officers soon realized that the only scientific field with a perspective broad enough to bridge among the multitude of complex issues involved appeared to be the newly emerging, interdisciplinary field of General Systems Science (GSS). The realization of the knowledge explosion and rapidly increasing technology had given rise to GSS as a conceptual approach for science in general. Its application for military problem solving also seemed imminent.

A system has been defined as a set of units with relationships among them. Briefly, a system is "an organized or complex whole." The diversity in types of systems has been noted by Dr. James Grier Miller: "There are systems of numbers and of equations, systems of value and thought, systems of law, solar systems, organic systems, management systems, command and control systems, and electronic systems." General Systems Science deals with the study of systems of any type.

The origins of the systems approach are somewhat obscure, but it may have begun in antiquity, when it was first observed that "the whole is more than the sum of the parts." However, until recently, scientific inquiry has been based primarily upon reductionism and therefore has failed to provide the integrated view of systems necessary for solving today's complex systems problems. The increasing technology of the early 1900's led some scientists to anticipate that specialization and reductionism would not provide complete answers to the increasingly complex problems generated by technology. This concern led to the beginnings of Systems Science, which have been traced to the 1920's with the Gestalt psychology of Koffka and the theoretical biology of von Bertalanffy. The major developmental impetus came during World War II when the evolution of operations research and systems engineering emphasized the advantages of a more general approach to human problems using interdisciplinary teams if necessary. The development of cybernetics and information theory accelerated the post-war formalization of the general systems approach.

Systems Science has been defined as "the ordered arrangement of knowledge ascertained from the study of systems in the observable world, together with the application of this knowledge" to the design, analysis, and evaluation of

systems. It involves the analysis of systems, the description of the interrelationships among systems or parts of systems, and the synthesis of these results to provide a deeper understanding of system behavior. Simply stated, Systems Science approaches consist of the following elements: an array of interconnected theories describing the structure and processes of systems; a methodology using pure and applied mathematical systems theory, tools of systems analysis, techniques of simulation and model building; and the application of the theories and methodology to problems in a variety of fields (e.g., systems engineering, operations research, human engineering).

Systems Science is by definition interdisciplinary: it encourages the transfer of concepts and techniques from one type of system or discipline to another. Consistent with its interdisciplinary transfer of concepts, Systems Science is composed of interdisciplinary workers from a variety of fields who work as generalists in the systems approach in order to apply their knowledge to systems problems in many areas.

### Living Systems Theory

The book Living Systems, upon which the TRADOC Systems Science Research Element (TSSRE) is based, was originally conceived in 1949 when Dr. James Grier Miller and a group of renowned scientists met weekly at the University of Chicago to discuss research in their particular fields. The discipline that attracted their attention was the newly emerging field of General Systems Science. Dr. Miller's interest in this field led him to positions at the University of Michigan, John Hopkins University, and the University of Louisville, where Living Systems was published in 1978.

Living Systems Theory (LST) is a general approach to describing and analyzing concrete systems at various levels of complexity. Living Systems are defined as open systems with both matter-energy (materials) and information inputs, throughputs, and outputs. LST is essentially a biologically based model and draws upon two major concepts. First, all living systems contain a minimum of 19 critical subsystems which must function if the system is to survive. Eight of these subsystems process matter-energy, nine process information, and two process both matter-energy and information (see Table 1 for a description). Second, seven levels of Living Systems exist, and all 19 critical subsystems can be found in each level (see Figure 1).

LST's central thesis is that these 19 processes (subsystems) are critical to any system's survival and that an analysis of these processes results in a fuller understanding of the system, its operations, and its pathologies. Thus, a valuable benefit of applying Living Systems Theory to the analysis of a system results from this focus on the processes of the system rather than on global factors such as goal accomplishment or on circumscribed factors such as individual productivity. The resulting examination of the organization is more comprehensive than that provided in more traditional management approaches.

TABLE 1

## The 19 Critical Subsystems of a Living System

## Subsystems Which Process Both Matter/Energy and Information

**REPRODUCER (RE)** - the subsystem which is capable of giving rise to other systems similar to the one it is in.

**BOUNDARY (BO)** - the subsystem at the perimeter of a system that holds together the components which make up the system, protects them from environmental stresses, and excludes or permits entry to various sorts of matter-energy and information.

## Subsystems Which Process Matter/Energy

**INGESTOR (IN)** - the subsystem which brings matter-energy across the system boundary from the environment.

**DISTRIBUTOR (DI)** - the subsystem which carries inputs from outside the system or outputs from its subsystems around the system to each component.

**CONVERTER (CO)** - the subsystem which changes certain inputs to the system into forms more useful for the special processes of that particular system.

**PRODUCER (PR)** - the subsystem which forms stable associations that endure for significant periods among matter-energy inputs to the system or outputs from its converter, the materials synthesized being for growth, damage repair, or replacement of components of the system, or for providing energy for moving or constituting the system's outputs of products or information markers to its suprasystem.

**MATTER-ENERGY STORAGE (MS)** - the subsystem which retains in the system, for different periods of time, deposits of various sorts of matter-energy.

**EXTRUDER (EX)** - the subsystem which transmits matter-energy out of the system in the forms of products or wastes.

**MOTOR (MO)** - the subsystem which moves the system or parts of it in relation to part or all of its environment or moves components of its environment in relation to each other.

**SUPPORTER (SU)** - the subsystem which maintains the proper spatial relationships among components of the system, so that they can interact without weighting each other down or crowding each other.

## Subsystems Which Process Information

**INPUT TRANSDUCER (IP)** - the sensory subsystem which brings markers bearing information into the system, changing them to other matter-energy forms suitable for transmission within it.

**INTERNAL TRANSDUCER (IT)** - the sensory subsystem which receives, from subsystems or components within the system, markers bearing information about significant alterations in those subsystems or components, changing them to other matter-energy forms of a sort which can be transmitted within it.

**CHANNEL AND NET (CN)** - the subsystem composed of a single route in physical space, or multiple interconnected routes, by which markers bearing information are transmitted to all parts of the system.

**DECODER (DE)** - the subsystem which alters the code of information input to it through the input transducer or internal transducer into a "private" code that can be used internally by the system.

**ASSOCIATOR (AS)** - the subsystem which carries out the first stage of the learning process, forming enduring associations among items of information in the system.

**MEMORY (ME)** - the subsystem which carries out the second stage of the learning process, storing various sorts of information in the system for different periods of time.

**DECIDER (DC)** - the executive subsystem which receives information inputs from all other subsystems and transmits to them information output that control the entire system.

**ENCODER (EN)** - the subsystem which alters the code of information input to it from other information processing subsystems, from a "private" code into a code which can be interpreted by other systems in its environment.

**OUTPUT TRANSDUCER (OT)** - the subsystem which puts out markers bearing information from the system, changing markers within the system into other matter-energy forms which can be transmitted over channels in the system's environment.

Furthermore, the approach scrutinizes interrelationships among various subsystems instead of proceeding as if each component were functioning in isolation. Thus, the subsystems are associated with groups of individuals and necessary equipment performing identifiable processes. Several processes may be performed in one component of a system or a process may be shared among several components. Some of a system's processes may be carried out by another system at the same or a higher level. The resulting analysis takes into account factors which might reduce or shorten the effectiveness of attempts to manage a complex modern organization.

LST also allows comparison of the structures and processes of systems at different levels. A set of 173 cross-level hypotheses has been proposed by Miller; these emphasize generalizations and identities which may be drawn concerning the operation and interaction of subsystems. Knowledge of a system's behavior at a given level can thus be generalized to other levels. Such an approach is useful in identifying general systems' pathologies (e.g., a missing, dysfunctional, or impaired subsystem) and in identifying general strategies for correcting them.

#### Living Systems in Army Vernacular

Although the concepts and postulates of Living Systems Theory (LST) as described above are understandable as stated, the application to Army battalions dictated some translation and further explanation/examples. First, LST states that in any organization such as an Armor battalion, only two major activities occur: the processing of information and the processing of matter/energy. This processing occurs in three basic stages: as inputs to, throughputs of, and outputs from the battalion (see Figure 2). In the Army, information such as statutory and executive directives, regulations, and technical manuals is blended with matter/energy (people, equipment, and facilities) to produce combat power. The application of LST is that it provides a focus on the processing (the events which occur) of information and matter/energy in a battalion.

In order to utilize LST for viewing an Army battalion it was necessary to conceptually link the 19 critical processes to a typical battalion structure. First, a mental construct is formed of the system to be examined. Figure 3 depicts the original model with the 19 processes represented. The battalion organization is represented within the boundaries as the Throughput medium. Carrying the construct another step forward requires specific matching of process to battalion activity. The information of Figure 4 provides a starting point for the investigation, as battalion components are identified by the process most associated with them.

## RESEARCH

### Phase I

"Application of Living Systems Theory to the Information Processing in an Armor Battalion" (December 1979).

#### Scope/Goals

The research reported here represents the first assessment of the relevance and utility of Living Systems Theory (LST) for understanding and maintaining control of changing interdependent systems in the Army. Since the research was basically exploratory, the scope of the project was limited to the accomplishment of the following objectives:

1. Identify and measure the relative efficiencies of the critical information-processing subsystems which underlie Training Management Activities (TMA) in the Armor Battalion.
2. Analyze the activities or functions of key system constituents from the standpoint of these LST processes, again concentrating on TMA activities in the Armor Battalion.
3. Delineate how the efficiencies of these LST processes relate to the measures of unit effectiveness traditionally used by the Army.
4. Identify, from the perspective of LST, the information-processing or organizational pathologies which tend to impair unit effectiveness in the area of training management and, where possible, suggest possible approaches to remedy these problems.

The scope of the project was limited to the critical subsystems which process information; to Armor battalion training management activities; and to selected variables and unit effectiveness indicators.

#### Methodology

The organizations studied were six U.S. Army armor battalions, four in the Continental United States (CONUS) and two in the United States Army-Europe (USAREUR).

The primary focus of the project was the battalion staff. Several data collection instruments were developed and administered to these key personnel. In addition, data were collected from approximately 100 soldiers (E6 and below) from each battalion. In all, 841 personnel were included in the research.

In order to relate processing of information to unit effectiveness, a measure of unit effectiveness had to be developed. There is a general lack of consensus throughout the Army concerning methods of evaluating battalion effectiveness using traditional data. To cope with this, a composite formula, similar to the one used by Deputy Chief of Staff Personnel (DSCPER), was used



to determine Battalion Effectiveness Rankings (BER):  $BER = 1/6$  (Command Indicators) +  $1/3$  (Performance Indicators) +  $1/2$  (Perception Data). The Command Indicator data refer primarily to personnel actions and strength levels within the battalion. Performance Indicators consist of the hard data found in an armor battalion (e.g., Qualification results). The Perception Data are the soldiers' feelings about their unit.

Following the data collection activities, the battalion commander and his staff were given a short out-briefing. Preliminary feedback on the data collected was provided to each battalion commander within 45 to 60 days following the visit to his unit.

### Findings

A common perception is that good battalions might be good because they spend more time on training management than do other battalions. These research data, however, do not support that perception. It was found that all battalions devote approximately half of their total duty time to training management. Thus, it is not the amount of time but the manner in which it is spent that separates more effective from less effective battalions.

Of the five information processing variables measured in this research, three have proven to relate strongly to battalion effectiveness. They are lag, distortion, and cost. All three are negatively related to unit effectiveness. That is, personnel in the more effective battalions indicate that information is provided and processed in a more timely fashion and with less cost, lag, and distortion than is the case in less effective battalions.

Figure 5 shows the relationship between lag and battalion effectiveness. The raw data were obtained on six-point rating scales on which 1 indicated "very low" and 6 indicated "very high." The "average" or middle of this scale therefore was 3.5. The highest composite lag rating of any battalion is 3.5, or average. This may occur because of assigning fairly rigid suspenses to tasks.

There is significant variation in the amounts of lag reported by specific personnel in the various participating battalions. Along the horizontal axis are the battalions arranged in order of effectiveness as defined by the traditional unit data. Here, 1 is the most effective battalion and 6 is the least effective battalion. If one were to draw a line through the midpoints of these bars, the line would have a slope clearly indicating that in more effective battalions, soldiers process information with less delay than do soldiers in less effective battalions.

Figure 6 shows that the relationship between lag and effectiveness differs, depending upon the training management activity examined. As before, average lag rating is on the vertical axis and the battalions are arranged in order of effectiveness on the horizontal axis. There is one panel for each TMA and the average for each is indicated by the dotted line which goes through that panel.

Different training management activities are associated with different amounts of lag. For example, "establishing training plans" and "resource management" have the most lag, and "training trainers and evaluators" and

"monitoring and evaluating training" have the least. Furthermore, although the slopes of the lines vary, they are all in a direction indicating that more effective battalions experience less delay in information processing than do less effective battalions. Battalion 3, however, does not fit neatly into this pattern: it frequently appears to be better than battalions 1 and 2. This is true in much of the data and may be due to the fact that this battalion had a new commander, extremely high morale, but poor statistics carried over from the tour of the previous battalion commander.

Just as the training management data show more details, so also do the data for the information processes. As on the previous graph, Figure 7 shows the average lag rating on the vertical axis and the battalions, arranged in order of effectiveness, on the horizontal axis. There is one panel for each of the processes. The dotted line in each panel is the average of the data points within that panel. The averages for each panel range between 2.5 and 3.5. Internal Transducing (IT) and Associating (AS) have the highest average lag ratings, while Memory (ME) has the lowest.

As before, although the slopes of the lines vary, they are all in a direction indicating that more effective battalions experience less delay in information processing than do less effective battalions. The relationship between lag and effectiveness is significant for all processes except those involved in inputting and outputting information (IP and OT).

Figure 8 reports the average distortion ratings (exaggeration, bias, or inaccuracy of the information being processed) for each of the six battalions. Distortion may characterize the information input into subsystems for processing or that which is produced within each unit as a result. Notice the bars indicate that the highest average distortion for any one battalion is 3.3 or below "average." Also, there is a fairly strong relationship between distortion and effectiveness, with less distortion present in the more effective battalions. Further, the number 3 ranked battalion, the anomaly, again appears to be almost as good as the first battalion in process terms.

The cost variable, shown in Figure 9, is also related to battalion effectiveness, although not as strongly as lag and distortion. Cost is defined here as the amount of time and effort required to perform a process. This graph presents the average cost rating for each of the battalions. In most of the units visited, processing information in general was rated as requiring average to above average time for completion.

Generally, however, information processing in more effective battalions is rated as requiring less time and effort than it does in less effective battalions.

Figure 10 displays the mean percentage of duty time (on the vertical) that is devoted to each of the specific processes (on the horizontal). The light bars represent data for the three most effective battalions as a group, and the black bars represent data for the three least effective battalions. Again, effectiveness is defined here in terms of ranking on the traditional unit data composite.

First, note that all battalions spend the greatest proportion of their time "internal transducing" (IT) and "deciding" (DC). These processes do not

clearly distinguish between more and less effective battalions. Rather, the more effective battalions tend to devote a greater proportion of their time to "input transducing" (IP). In contrast, less effective battalions spend more time "encoding" (EN) and "output transducing" (OT).

In addition to assessing the meaning, volume, cost, lag, and distortion of processing information, subjective evaluations of process efficiency were obtained and agreed fairly closely with the objective evaluations.

Figure 11 shows the efficiency rating on the vertical axis and the processes along the horizontal axis. The light bars indicate data for the more effective battalions, BERS 1, 2, and 3. The black bars indicate data for the less effective battalions, BERS 4, 5, and 6. Generally, the more effective battalions are seen as more efficient in the performance of each of the processes. Less effective battalions are evaluated as less efficient in processing information, regardless of the specific processes.

The data presented so far are a description of the unit as a whole. However, part of the research involved asking battalion personnel to describe their own jobs. These data were analyzed to determine significant contributions that specific positions made to the accomplishment of the nine information processes. Although there were few consistencies among the battalions regarding contribution to the processes, some trends emerged when position data for the more and less effective battalions were compared. These trends describe how components distribute their time in more and less effective battalions. Living Systems Theory really comes alive when one uses process analysis to describe the soldiers (that is, the components who make up the Armor Battalion) who make training happen. The following description is of course tentative because it is based on a very small sample. But the insights provided by even these few cases are useful.

In Figure 12, again the light boxes represent more effective battalions, the dark boxes less effective battalions. Along the vertical axis is the total percent of time that the various soldiers devote to training management activities. Along the horizontal axis are the soldiers interviewed. They range from Battalion Commander down to the Training NCO. In more effective battalions, Battalion Commanders spend approximately 75% of their total duty day on training management activities. In less effective battalions, Battalion Commanders appear to be spending approximately 65% of their time in training management.

Shown in Figure 13 is what the Battalion Commander, XO, and S-3 are doing with their time across all the information processes as they relate to the training management activities of the battalions. Battalion Commanders are doing the two things that one would traditionally expect them to do. First, they are monitoring and supervising unit activities (IT). Second, they are creating information to make things happen--that is, making decisions (DC).

In the more effective battalions, the Battalion Commanders spend more time accomplishing these two processes. Contrast that with the less effective battalions. For example, under monitoring and supervising unit activities (IT), in the more effective battalions the Battalion Commanders spend approximately 20% of their time monitoring and supervising unit activities, whereas in the less effective battalions, they spend only about 15% of their

time in this way. Battalion Commanders in less effective battalions concern themselves with outputting information (OT). In general, they seem to be mired down in the "paperwork syndrome" and reports.

In the more effective battalions (represented by the light column on the left) Battalion Executive Officers (XOs) spend approximately 30% of their time in conducting training management activities. But in the less effective battalions, Battalion XOs are spending 80% of their time on training management activities. The traditional role of the Armor Battalion XO is to oversee the logistics and maintenance operations of the battalion. But it was found that Battalion XOs in less effective battalions spend their time in training management. XOs in the less effective battalions spend time in deciding and monitoring, perhaps taking up the slack left by the Battalion Commanders' concern with outputting.

The research indicates three components are critical to effective training: the Battalion Commander, the Battalion S-3, and the Company Commander. For example, S-3s spend approximately 90% of their time in training management activities. That is the case in both more and less effective battalions.

What has been shown so far is that Living Systems Theory concepts are at least as adequate as traditional perspectives in describing Armor Battalions. It has also been shown that these concepts can be used to distinguish among battalions in terms of effectiveness. As pointed out before, the concepts can be used to help identify sources of problems among battalions by looking at the components within the battalions.

Living Systems Theory can help not only to describe phenomena, but also to identify sources of problems. According to the theory, the "health" of a system is determined by the health of its subsystems or processes. Five variables were used to measure the state of these processes: meaning (M), volume (V), cost (C), lag (L), and distortion (D). It seems that for information processing to be healthy, a system would have a lot of meaningful information being processed at relatively low cost, lag, and distortion.

The "health ratio" is represented by the following formula:

$$HR = \frac{M + V}{C + L + D}$$

The values for meaning and volume are divided by the values for cost, lag, and distortion; this provides a constructed measure of the health of the battalion. As an example, take the most effective battalion and the most efficient of the processes, memory. Putting the values for the five variables that make up the health ratio into the formula, we arrive at a value of 1.33. For the least effective of the battalions, we arrive at a ratio of 0.94. In other words, the ratio does distinguish between the more and less effective battalions. The higher the ratio, the higher the health of the battalion.

The data from the health ratios can be used to diagnose sources of problems. That is, even healthy battalions have unhealthy subsystems. These might be sources of difficulty which can be analyzed more fully and corrected.

### Summary

As a reminder, Figure 14 briefly shows the general findings from this research effort. The study demonstrated the descriptive and diagnostic utility of Living Systems Theory as a research technique which can be employed to analyze Army organizations and to provide practical recommendations for increased efficiency in organizational management.

The research looked at only a small number of Army units and concentrated on information processing as it relates to training management activities. The descriptive and diagnostic characteristics of Living Systems Theory, coupled with the theory's potential for prescription in the study of complex problems, are applicable to all levels of organizations. The implications of this major breakthrough for the promulgation of systems theory, both General and Living Systems Theory, are significant.

## Phase II

"Application of Living Systems Process Analysis to the U.S. Army Battalion" (January 1981).

### Scope/Goals

Due to the results of the Phase I research (above), a follow-on effort was initiated. However, the CG TRADOC expanded the scope substantially. This research would consider all 19 processes as they occur in the full range of battalion functions - Training, Personnel, and Logistics. Further, the research would look at all types of units - Combat, Combat Support, and Combat Service Support. The initial goals of this phase were:

1. To describe the processing of information and matter/energy through Army battalions.
2. To relate the quantity and quality of the processing to unit effectiveness.
3. To develop analytical techniques for identifying process inefficiencies which impede unit effectiveness.
4. To propose techniques for improving information and matter/energy processing to enhance unit effectiveness.
5. To provide timely, usable feedback to participating units.

Although Phase I research revealed Living Systems principles were readily understandable by almost everyone, it was decided to "green" the terminology to enhance understanding. Thus, the process names and symbols were changed to communicate their meaning more readily. The definitions were also modified to provide examples from within battalions. Table 2 provides the revised terminology.

### Methodology

Conceptual Model - Phase I research provided the basis for formulating a data collection model. It had employed the "traditional data" elements found in battalions (Soldiers' Opinions, Command Indicators, and Performance Indicators) along with "Process Perception Data" (the perceptions of unit members about LST processes seen from a variety of perspectives). Although a usable relationship was established, it was decided to try to strengthen it through the addition of a third parameter: "Objective Process Data" (data available within a unit which reflect on a specific LST process without including a member's opinion). Together, these three data elements formed the conceptual basis for Phase II.

TABLE 2  
PROCESS DEFINITIONS

<u>ABBREVIATION</u>	<u>PROCESS</u>	<u>DEFINITION</u>	<u>EXAMPLE</u>
IN	INPUT	Obtaining information from outside the battalion.	Requisition status reports, supply bulletins, etc.
MN	MONITOR	Obtaining & reporting information regarding battalion activities.	Daily equipment status reports, SIDPERS information, etc.
CR	CIRCULATE	Relaying information within the battalion without change.	Face-to-face communications, telephone, bulletin boards, etc.
DE	DECODE	Making information usable within the battalion.	Battalion SOP's, job books, etc.
RL	RELATE	Pulling information together to recommend change.	LOSS projections, AGI responses, etc.
RE	REMEMBER	Storing & retrieving information within the battalion.	Files, notebooks, printouts, etc.
DC	DECIDE	Using information to make decisions controlling the battalion.	Prioritized actions, cross-leveling for parts, etc.
EN	ENCODE	Preparing external reports & requests.	Preparing requisitions, the 2715 reports, etc.
OT	OUTPUT	Sending reports & requests outside the battalion.	Sending the 2715 report up, submitting SIDPERS transactions, etc.
RC	RECEIVE	Bringing materiel/resources into the battalion.	Getting replacement parts or personnel in, etc.
DI	DISTRIBUTE	Carrying materiel/resources around the battalion.	Passing repair parts to mechanics, serving food, etc.
TR	TRANSFORM	Reworking materiel/resources for use by the battalion.	Sawing wood, physical conditioning, etc.
PR	PRODUCE	Making products needed by the battalion.	Repairing broken equipment, cooking food, etc.
ST	STORE	Storing materiel/resources within the battalion.	Parts bins, foot & wall lockers, etc.
RM	REMOVE	Removing materiel/resources from the battalion.	Outprocessing personnel, DX of vehicles, etc.
MV	MOVE	Moving the battalion or parts of it.	Vehicles & drivers moving personnel, equipment, etc. to the field for an FTX.
SR	STRUCTURE	Setting up and maintaining proper work areas.	Offices, maintenance bays, buildings, etc.
RP	REPLICATE	Reproducing the battalion.	Using information, equipment, and manpower to form a new battalion.
EN	ENCLOSE	The physical area of operation/occupation of a battalion.	The police and/or maneuver area assigned.

Figure 15 diagrammatically illustrates the model. Thus, these three interrelated, though different, views provided a clearer understanding of unit effectiveness. The data were collected using a variety of techniques including mass administration of questionnaires, interviews with key management personnel, records and reports available within the unit, surveyor completed checksheets, and surveys from brigade level managers. In all, approximately 50-75 key personnel were involved per unit with an additional 80-100 soldier-level (E4 and below) completing a shorter questionnaire. Figures 16 and 17 provide a detailed description of the sample. As may be seen in these figures, a total of 35 active duty Army battalions from both the Continental United States (CONUS) and United States Army-Europe (USAREUR) were included.

As discussed earlier, the first set of data--traditional unit data--includes measures normally used to assess Army unit effectiveness. These measures fall into three categories (see Figure 18), based on the DCSPER calculations (DCSPER = Deputy Chief of Staff for Personnel) originally developed several years ago. The DCSPER formula combines performance indicators, command indicators, and perceptions into a single, aggregated measure of effectiveness. These indicators have been found to be useful because they can be reported fairly accurately across units.

The original DCSPER formula weighted the three data sets so that performance indicators accounted for one-third of the measure, command indicators for one-sixth, and perceptions for one-half. In both the past and current research, it was found that both the weighted DCSPER formula and an unweighted formula work about equally well in distinguishing among units in terms of effectiveness. Also, it was found that these various measures correlate fairly well. That is, they are all apparently assessing some unidimensional notion of effectiveness.

The traditional unit data are important in two ways. First, the data represent a reasonably accurate and fairly widely accepted means by which to describe various aspects of unit effectiveness. More important, these data can be used to distinguish among units. Thus, this phase of research continued the use of the Battalion Effectiveness Ranks (BER). The BERs served as reference points against which process-analytic findings could be compared.

The second element within this conceptual model consists of the process perception data. These data, collected from the several instruments of the study, focus on various ways of describing and evaluating the processing of information and materiel/resources within units (Figure 19). In the current analysis four types of perception data are used. First, the STATE of each process is examined: how well the process is being accomplished, from the point of view of the personnel within the unit. Second, the TIME spent on the processes is examined: both for a unit as a whole and for the members of that unit, how much time is devoted to each process. Third, the IMPORTANCE of each process is examined: how important the process is relative to the other processes. Finally, the PERFORMANCE of each process is examined: how well the process is carried out in terms of usefulness, accuracy, timeliness, cost, and volume (the process variables).

The third element of the conceptual model is made up of process objective data. Like traditional unit data, these data can be obtained on a regular



basis within the unit (Figure 20). And, like process perception data, these data focus on specific information and materiel-resources processes. For example, the percentage of a unit's vehicles which are operational may serve as an indicator of the quality of the unit's moving process.

The process objective data seem to be related both to process perception data and to traditional unit data. For example, both from a process perceptual and a process objective point of view, units may be distinguished in terms of the degree to which there is accuracy in the remembering process (Figure 21). More effective units are characterized by greater accuracy as perceived by personnel within those units. These units also have a higher percentage of up-to-date training materials on file. The latter is thus a rough indicator of process accuracy.

The process objective data also seem to be related to the traditional unit data. For example, more effective units also report a lower level of personnel actions. Fewer personnel actions may indicate a lower level of personnel turbulence. They may also be viewed as an indicator of the volume of personnel information being processed by the unit.

It is important to stress that the process objective data are, so far, very preliminary. The definition of the appropriate indicators of processes is still very tentative. Also, the methods to ensure reliable, continuous collection of the data must still be established. Nonetheless, these preliminary findings suggest that this third element of the conceptual model may play an important role in establishing the boundaries of unit effectiveness.

### Findings

Process Data - The process data refer to the living systems processes as viewed from the four perspectives of STATE (how well a process is reportedly done), TIME (the % of time reportedly spent in each process), IMPORTANCE (the rank order of the processes in terms of importance to mission accomplishment as reported), and Process Performance Index or PPI (a constructed measure of process efficiency utilizing 5 variables -usefulness, accuracy, timeliness, cost, and volume). Combining the data into a single matrix for understanding resulted in Figure 22, which illustrates the complexity and volume of data utilized.

Using Discriminant Analysis based on BER group association, profiles or fingerprints for each process within High/Med/Low BER battalions emerged, not only with respect to each perspective, but also for the 3 areas (Training-TNG, Personnel-PER, Logistics-LOG). While the findings hold across each perspective, a few examples from STATE will help to clarify the situation.

TNG: In the area of training, it was found that the state of the inputting, monitoring, remembering, encoding, receiving and structuring processes differentiates battalions of different levels of effectiveness. Thus, the high BER units are clearly distinguishable from both medium and low BER units (and vice versa).

PER: Individuals in the personnel area view processing a bit differently. Here, the processes of monitoring, relating, receiving, transforming, removing, and moving discriminate between units of different levels of effectiveness.

LOG: Logisticians provide yet another view. Now, the processes of circulating, distributing, transforming, producing, receiving, and inputting provide the discriminating power.

Therefore, by using Living Systems Process Analysis (LSPA) one can distinguish, rather definitively, between battalions of high BER effectiveness and those of medium or low effectiveness. Further, this may be accomplished within each functional area--Training, Personnel, and Logistics. Additionally, regardless of the perspective used (STATE, TIME, IMPORTANCE, or PPI), in the high BER effective battalions the focus is on information processing. This focus characterizes the high effective units as being different from medium and low effective ones. These findings indicate that in addition to describing Army battalions, LSPA can also provide information on actual differences between units of different levels of BER effectiveness.

Component Analysis - A thorough discussion/explanation of why the difference exists is not as yet available. However, a partial explanation centers around the battalion components (individuals) who actually carry out the processes. It is clear from the analysis that unit effectiveness depends heavily on efficient processing of information. But how can these findings be translated into a pragmatic tool for use in the real world of the U.S. Army?

Information processing entails a number of different operations--the nine processes described earlier. Obviously, many individuals within a unit are involved in one or more of these processes. An understanding of how unit personnel distribute their time among these processes is likely to be critical in determining how unit effectiveness is accomplished.

In Phase I of the research, it was found that information processing time differed between more and less effective units. Again, looking first only at training information in armor battalions, a great deal of similarity exists between the findings of Phase I and those of Phase II (Figure 23). Specific percentages of time have changed to some degree. This change is likely due to two factors. First, the definitions of the processes have been somewhat altered in order to conform better to Army usage. Second, and more important, in Phase II personnel were asked to consider both information and materiel/resources. Thus, the context has been altered somewhat.

Nonetheless, the essential differences between more and less effective units remain. In more effective units more time is spent in monitoring training and in making decisions about training. In less effective units more time is spent on processes likely to be associated with paperwork--preparing reports and sending information out from the unit.

In Phase II, PER and LOG were examined as well as TNG. Therefore, before examining Training in more detail, the findings concerning Personnel and Logistics will be briefly discussed.

As can be seen in Figure 24, in PER, more time is spent in information processing than in materiel/resources processing in both more and less effective units. But in more effective units, significantly more time is spent on getting information into (Inputting) and out from (Outputting) the unit and in maintaining useful administrative files (Remembering). That is, more effective units seem to maintain a more efficient paper flow necessary for successful personnel management. Less effective units, in contrast, spend more time in monitoring and deciding. This suggests that there may be more personnel problems in these units or that these problems are handled less efficiently.

Interesting differences can also be noted in LOG (Figure 25). In general, more effective units spend more time in managing logistics activities. In less effective units, personnel are more involved in the actual manipulation of materiel/resources. In general, more effective units seem to manage the information flow necessary for logistics support. They especially emphasize bringing in the necessary information (Inputting) and coordinating and consolidating this information (Relating) for the unit and for outside the unit.

In the TNG area, what is especially important is the analysis of process time for TNG (Figure 26). Training process time is displayed in two ways: first, the average time per process for all individuals involved in training, comparing more and less effective units; second, the average time per process for the individuals in the S-3 Section, again comparing more and less effective units.

Looking first at overall training time, it is clear that more effective units, as a whole, spend significantly more time finding out what is happening in training (Monitoring) and in using information to make procedural changes (Relating) and decisions necessary to make training happen (Deciding). In less effective units, significantly more time is spent on such things as storing and retrieving training materials (Storing).

The fact that more effective units spend more time in critical information processes is important in itself. But what makes this finding useful is to see how this time is distributed among key personnel in the unit. In more effective units, the S-3 Section spends a great deal of time in three processes--bringing training information into the unit (Inputting), using information to make long-term procedural changes (Relating), and making decisions about training (Deciding). These are the processes upon which an effective S-3 shop probably should be concentrating.

The S-3 Sections in more effective units do not, however, spend as much time in monitoring training. Yet it was shown that, overall, monitoring merits a good deal of time in more effective units. Who then is carrying out these processes? It is clear that in more effective units, the battalion and company commanders play a large role in monitoring (Figure 27). This is as it should be. That is, information about how well training is proceeding should be generated within the unit, but not necessarily only from within the S-3 shop. In the more effective units, the S-3 Section seems to be more open. It is receiving important information from within the unit, and then using that information to make improvements in training. In less effective units, the S-3 Section seems more closed. It involves itself in monitoring training and

in circulating training information--processes perhaps best left to others--rather than in relating and deciding. It seems to be receiving less information from the executive levels, which might well be able to provide more timely and accurate information on the progress of training.

S-3 Sections in more and less effective units process training information in different ways. It is important to look at the key personnel who make up these sections (Figure 28). The S-3 in more effective units spends a good deal of his time in bringing information into the section and using it to make procedural changes and to make decisions. The S-3 in less effective units, in contrast, spends perhaps an inordinate amount of time circulating information and preparing and outputting reports. The Asst S-3 and the Opns NCO in less effective units are also spending a great deal of time preparing reports and outputting information. The Asst Opns NCO in the less effective units spends very little time on these processes, but is perhaps the one who should spend more time on these processes, particularly in preparing routine reports. If he were to do this, it would free time for other personnel to concentrate on planning and coordinating training--that is, on the processes necessary to make training happen.

The Asst S-3 should have a large amount of responsibility for preparing new training information, responsibility which entails a large amount of decoding and relating. In more effective units, this is precisely what the Asst S-3 does. But in less effective units, his counterpart spends time in preparing reports and outputting information. The Asst S-3 spends more time in deciding, perhaps in order to compensate for the S-3's smaller time allotment for this process.

The process analysis can be carried further to look at specific processes for specific personnel (Figure 29). More effective units spend more time bringing information into the unit. Again, in general, key personnel in more effective units spend more time bringing information into the unit.

This method of displaying the time data makes comparison of positions easier, especially for those processes for which overall time data disguise important differences among personnel. For example, the process of circulating information without change is an important, though essentially clerical, task. Yet, in less effective units, both the S-3 and the Asst S-3 spend a good deal of time in this process. In fact, the S-3 spends approximately 10% of his total duty time on this process. This is likely a poor use of his time; he should probably be engaged in making decisions to promote successful training.

A note of caution: The process analysis of time is a pragmatic tool. It was developed as a means by which to identify sources of problems. If the S-3 in less effective units is spending an inordinate amount of time circulating information, it is not the time spent per se that is the problem. Rather, the time spent is a possible indicator of underlying problems in the S-3 shop. As research progresses, hopes are to establish norms which will allow clearer determination of specific misallocations of time.

### Summary

The research findings reported above represent only a small portion of the current and potential results of the Living Systems Process Analysis. These findings, however, make clear both that Living Systems Theory has scientific validity and that the application of the theory has practical uses in organizations such as the U.S. Army.

As the current findings have demonstrated, Living Systems Process Analysis serves both to describe the ways in which battalions process information and materiel/resources and to associate information and materiel/resources processing with differing degrees of unit effectiveness. The application of the process analytic techniques to groups and individuals which make up the battalion permits the identification of potential sources of problems which might impede unit effectiveness.

The tremendous data base obtained from Phase I and II of the research has provided the opportunity to develop process norms with which to gauge unit effectiveness and to identify problems, the solution to which will enhance effectiveness. Process norms can thus be used by unit commanders to assess how well the unit as a whole is carrying out essential information and materiel/resource processes. Such norms can be developed for individual sections within units and even for individual personnel who make up these sections.

These norms, combined with more immediate feedback of unit process data, can become a significant tool for monitoring unit performance on a continuous basis. Ultimately, unit effectiveness may hinge upon this approach.

## Norms Study

"Performance Norms for the U.S. Army: A Preliminary Analysis." (November 1981)

### Scope/Goals

The scope of this study was to provide information which could be used to evaluate a battalion's performance from a "process perspective" and to guide a battalion's efforts to improve this performance. In carrying out the research, a data base was generated from studies of 35 U.S. Army battalions (Peter and Ruscoe, 1981; Merker and Ruscoe, 1981), which included over 5000 respondents from 13 Continental United States (CONUS) and 22 United States in Europe (USAREUR) battalions representing a variety of combat, combat service, and combat service support battalions. The respondents represented a large group of officers, NCOs, and lower-ranking enlisted personnel (E4 and below) from these battalions.

In this research, the intent was to provide means by which a battalion can determine the extent to which its operations and activities are potentially "pathological" and the types of remedial action which might be initiated in order to counteract these potential pathologies. An organization, like an organism, cannot survive when its basic processes are impaired. Moreover, anyone who attempts to "diagnose" an organization, like a good doctor, must deal with the etiology of disease, not merely its symptoms. That is, to treat organizational symptoms without addressing the underlying causes of these symptoms is much like treating a patient's high blood pressure without addressing questions such as tension. More specifically, if the U.S. Army attempts to correct low-level proficiency of its enlisted personnel without considering why these personnel exhibit low levels of proficiency, the Army has clearly failed as an organizational diagnostician.

In attempting to develop the means by which a battalion (or, more precisely, the battalion commander) can diagnose and prescribe remedies for the problems of the unit, the research concentrated on those LST process variables which seem to be especially indicative of organizational pathology.

In order to be useful, the establishment of norms must be directed simultaneously at two related tasks. On the one hand, norms may refer to those middle regions of the distribution of some variable which describe the typical or average variate values. The "norm" for a particular LST process, for example, can be defined as that set of variate values which comprises some middle range of values--say,  $\pm$  one standard deviation from the mean. On the other hand, norms may sometimes refer to some notion of "ideal" variate values. If, for example, one seeks to identify the variate values of a particular LST process associated with battalions identified as highly effective, the "norms" thereby established represent some ideal toward which less effective battalions may strive.

Thus, the goal was two-fold: 1) to provide baseline data by which to describe the average variate values of the LST processes and 2) to provide selective data by which to describe the variate values characteristic of

highly effective battalions. The normative tables developed for the research contain both types of data. These tables will permit a battalion commander to compare his unit both to the average or typical unit and to more effective units. Such comparisons allow assessment both of where the battalion is and where the battalion ought to be, given the goal of increasing unit effectiveness.

The normative tables provide information by which to gauge a battalion's position for each of the major data points contained in the data base. Included with the tables is the Performance Indicator Scale. This Scale permits a commander to determine, for any data point, where his/her battalion stands relative to the 35-battalion data base.

It is not recommended that a commander attempt to use all of the normative tables at any one time. Such an attempt would be extremely time-consuming. More importantly, it would produce a highly complex set of numbers which would, precisely because of this complexity, fail to highlight those problems or pathologies which are likely to be crucial to battalion effectiveness. Instead, the normative tables should be considered the necessary numerical backdrop against which to view specific norms or specific problems. Deviations from these norms can then be corrected by the appropriate remediation.

As mentioned earlier, the previous LST research (Ruscoe et al., 1979; Peter and Ruscoe, 1981; Merker and Ruscoe, 1981) has demonstrated that there is a fairly consistent relationship between the effectiveness of U.S. Army battalions as measured by traditional Army indicators (combined into Battalion Effectiveness Ranks, BERs) and the process-analytic findings of the Systems Science Institute research. In addition, the process-analytic findings reveal a good deal more about the inner working of the battalions and help to identify pathological conditions which hamper effectiveness.

In establishing norms by which to evaluate a battalion, it is first necessary to determine those process variables which seem to be especially important because of their strong association with battalion effectiveness. From the point of view of Living Systems Theory (LST) or even General Systems Theory (GST), one would predict that the various measures of a system would show a high degree of intercorrelation. That is, if a system is functioning effectively, its subsystems are also likely to be functioning efficiently. An Army battalion judged to be effective is likely to have a high degree of efficient information and material/resources processing.

For this reason it is not surprising to find that the large majority of process-analytic measures are correlated to some degree with battalion effectiveness. From a theoretical point of view, the logical consistencies of a model such as LST, if the model is to be fruitful, should be supported by empirical consistencies. In the several analyses completed to date (Ruscoe et al., 1979; Peter and Ruscoe, 1981; Merker and Ruscoe, 1981), the findings clearly support this requirement. Especially relevant is the fact that the processes deemed "critical" by LST do in large measure serve to discriminate among battalions of differing effectiveness.

But in a sense some of these critical process-analytic measures are more critical than others. That is, certain process variables and combinations of

variables are more highly correlated with battalion effectiveness than are others--they discriminate better, in effect. It is thus possible to use correlational criteria to sift through the mass of data and to identify those data elements which seem to be especially crucial because of their strong association with battalion effectiveness.

### Methodology

An important part of Living Systems Theory (LST) focuses on the relationship between the variables which characterize the 19 critical processes, on the one hand, and, on the other, the overall functioning of the system. Because the process variables are themselves somewhat intercorrelated, an examination of the simple variable-BER correlations may be misleading. The correlation of a single variable with BER may ignore the indirect effect of other process variables which interact with the first. Therefore, it is useful to perform a multiple correlation analysis to determine the amount of variance in BER accounted for by a combination of variables. This approach permits the identification of the set of variables most significantly influencing battalion effectiveness.

Multiple correlation examines the relationship between a dependent variable (in this case, BER) and two or more independent variables considered simultaneously. Such an approach provides a clearer understanding of the relationship between BER and the process performance variables, given that the latter are fairly highly correlated.

Multiple correlation analysis can be applied to each area of battalion specialization: training, personnel, and logistics. Each resulting model can be designed to maximize its explanatory power and, at the same time, to facilitate recommendations for remediation. That is, the models present those sets of process variables which most strongly account for variations in battalion effectiveness. At the same time, the models present further elaboration of those process variables which do not appear to be readily accessible to remediation. Thus, each model attempts to trace battalion effectiveness to those process variables which are both critical to effectiveness and susceptible to remediation.

### Findings

In developing the training model, the first concern was to determine that set of process variables which accounts for most of the variance in battalion effectiveness as measured by BER. As may be seen in Figure 30, it was found that two process variables are especially important in predicting effectiveness--accuracy in monitoring training (IT) and making training decisions (DC).

This Figure suggests that, in training, the relationship between process variables and battalion effectiveness can best be understood--and remediated--by concentrating on the accuracy with which the battalion's training activities are monitored (IT) and the accuracy of the information used to make decisions which regulate or guide these activities (DC). As will be seen later, it is possible to identify those remedial actions which might be taken to improve IT accuracy.



But DC accuracy seems to be much less amenable to direct remediation. That is, DC accuracy depends at least in part on the accuracy of the information coming into the decider. This dependence is illustrated in Figure 31. Results indicate that DC accuracy is fairly strongly related to the accuracy of the information which is decoded for use within the battalion (DE), the accuracy of the information stored and retrieved within the battalion (ME), and the accuracy of the information used to develop and recommend changes in battalion training procedures (AS). Each of these processes can be remediated directly, thereby indirectly increasing the accuracy of decision-making. Statistics indicate that each of the three process variables will contribute to DC accuracy, with ME accuracy promoting somewhat greater improvement. Thus, it is to be expected that remediation of any process variables will also contribute to improvements in the other variables.

The complete training model (shown in Figure 32) thus represents several points at which remediation can be introduced into the battalion in order to improve training and, subsequently, overall battalion effectiveness.

The training model presented in Figures 30, 31, and 32 represents a picture of the relationship between critical process variables and battalion effectiveness. While the model helps to make clear how training might be improved by remediating these process variables, it does not provide sufficient information as to the way in which a battalion commander can determine whether these process variables are in fact in need of remediation for his battalion.

To make this determination, it is necessary to introduce a means by which process norms can be applied to a specific battalion. This application can be achieved by use of the Performance Indicator Scale developed for the 35-battalion data base. The Scale permits a battalion commander to determine the position of the battalion relative to the data base for any process variable or for any combination of variables. The format for the Scale is presented in Figure 33. The Scale has been designed so that the norm for each process variable can be plotted on this single scale.

For each variable, the average ( $\bar{X}$ ) from the 35-battalion data base is reported in the normative tables. This  $\bar{X}$ , translated into the standard-score units used in the Scale, represents the mid-point or 0 of the Scale. Also included in the normative table is the standard deviation (SD) for each variable. The SD represents how much, on the average, each of the 35 battalions deviates from the  $\bar{X}$  for the 35. The SD can also be translated into standard-score units. One SD above  $\bar{X}$  is equivalent to a standard score of +1.0. One SD below  $\bar{X}$  is equivalent to a standard score of -1.0.

The utility of the Performance Indicator Scale in examining the training model can be appreciated by examining each of the model's process variables in terms of the high and low effectiveness battalions (i.e., high and low BERs). For example, on the reported accuracy of monitoring battalion training (IT, Figure 34), the high BERs report quite high accuracy, relative to the total data base, while the low BERs report very low accuracy. This difference persists for the other four process variables.

Thus the training model identifies those process variables which not only are associated with battalion effectiveness overall but also clearly distinguish between the very high and the very low BERs. The model, in conjunction with supporting Performance Indicator Scales, can be used both to identify potential problems which may hinder battalion effectiveness and to locate those points at which these problems may be remediated.

Battalion effectiveness hinges at least in part on how well the various information and matter/energy processes are performed. Also of concern is the extent to which time devoted to different processes is associated with effectiveness.

Unlike the process performance analysis, however, the time analysis is constricted by the fact that the total amount of time available--100%--is a constant. If time for a process is increased, then time available for other processes must decrease. In contrast, for process performance, an increase in the performance of one process does not necessarily entail a decrease in performance of other processes. In fact, given the fairly strong interdependence of the processes, increased performance in one process may stimulate increased performance in other processes as well.

In the case of training, of utmost importance is the amount of time devoted to monitoring training (IT), to developing and recommending changes in battalion training procedures (AS), and to making decisions that control and guide the battalion's training activities (DC).

As may be seen in Figure 35, more and less effective battalions differ significantly in terms of IT time. High BER battalions fall well above the average in percent of time devoted to this process while low BER battalions fall below. Given the obvious importance of monitoring battalion training as a means to promote up-to-date, effective training, the differences between high and low effectiveness battalions in the time spent on this process are revealing and suggest a possible point for remedial action. It is important to point out here that a battalion commander may quickly gain a first approximation of how well his battalion is tackling training problems by comparing the battalion's IT time to the data-base norm encompassed in the Scale in Figure 35.

In addition to examining the amount of time spent in the processing of information, it is also necessary to examine how key personnel (components) of the battalion spend their time and how these time allocations are interconnected. Components in high and low effectiveness battalions spend their training time in significantly different ways.

Certain processes within the information group have been shown to be more important than others in distinguishing between more and less effective battalions. Especially important are the time spent in 1) monitoring battalion training (IT), 2) using information to develop and recommend changes in battalion training procedures (AS), and 3) making decisions which control and guide training (DC). These processes are also critical to the overall time analysis as well as to the earlier performance analysis.

Looking at the process of monitoring (IT), it is clear that, in more effective battalions, the monitoring of training represents a significant part

of the duties of the S-3, the platoon leaders, and the total company-level leadership. That is, in more effective battalions, the monitoring of training is very much a joint effort, involving both the S-3 section and the lower level echelons of the battalion.

It would be misleading, however, to view monitoring (IT) as the province only of these components. Other members of the battalion, including the commander himself, play important roles in this process, even if the differences between more and less effective battalions are not always statistically significant.

### Summary

The process analysis developed greatly extends understanding of the dynamics of battalion effectiveness. The analysis permits the establishment of process norms by which battalion leaders can compare their battalion to a broad-based sample of Army battalions. This comparison can be made for a single variable or for a combination of variables.

The use of process analysis has been demonstrated principally through an examination of the process of monitoring battalion training (IT, internal transducer). Differences between more and less effective battalions in IT performance, in overall time devoted to IT, and in component time devoted to IT suggest that remediation directed at this process will promote battalion effectiveness. Tentative procedures for this remediation are being developed in the Battalion Systems Analysis Package (BSAP).

## CONCLUSIONS AND IMPLICATIONS

### Introduction

It is necessary to note that the present studies have looked at a moderately small range of battalions, considering the various types and categories of battalions that exist. Moreover, these studies have concentrated on the garrison operation of these battalions' training, personnel, and logistical activities. Nonetheless, the results have broader applications and implications than are indicated by the number or specific types of battalions examined. This section will briefly summarize the findings of Phase I, Phase II, and the NORMS study, but more importantly, it will consider at some length the implications and further applications of the Living Systems Process Analysis (LSPA) to an analysis of serious Army concerns.

Phase I - (AUG 1978 - DEC 1979) - Application of the Living Systems Approach to the Evaluation of Critical Processes in the Armor Battalion: An Exploratory Analysis - This pilot research project was a cooperative effort combining the resources of the University of Louisville, the Army Research Institute, and HQ, Training and Doctrine Command. The purpose of this research was to apply Living Systems information processing concepts to an analysis of the training management activities of six armor battalions, four in the United States and two in Europe. Data regarding the processing of information in nine critical processes were collected from key brigade, battalion, and company personnel using a variety of surveys and structured interviews. Traditional measures of unit effectiveness were also collected and compared to LSPA results.

These data were used to determine the relationship between process analysis and traditional measures of effectiveness, to describe the battalions and their components in terms of the process variables, and to diagnose problems hampering unit effectiveness. The findings indicated that LS concepts distinguished among battalions in much the same way as did traditional measures of unit effectiveness. At the same time, LS process analysis revealed much more about the internal dynamics of the units. For example, more effective battalions processed information with less cost, lag, and distortion than did less effective battalions. In addition, the process analysis permitted an examination of the division of labor within the unit and a tentative identification of dysfunctions within this division. Health Ratios and Health Profiles were developed to describe organizational health and to diagnose potential pathologies. Health analysis was found to be a tool for monitoring the activities of the unit and for focusing on problems, the remediation of which could be expected to increase overall battalion effectiveness.

Thus, this pilot study provided some indications of the potential descriptive and diagnostic utility of Living Systems as a research technique and developed the Living Systems Process Analysis (LSPA) which can be employed to analyze Army organizations and to provide practical recommendations for increased efficiency in organizational management.

Phase II - (JAN 1980 - APR 1981) - Application of Living Systems Process Analysis to Critical Activities of the U.S. Army Battalions - This research project was an extension of the Living Systems pilot study described above.

This project, again in conjunction with the University of Louisville, combined the resources of the Army Training Board, the Army Research Institute, and HQ, TRADOC to apply LS concepts to an analysis of the management of personnel, logistics, and training activities within Army battalions. The main objectives were as follows:

Analyze the flow of materiel/resources and information through the battalion in terms of the 19 critical processes identified by LS.

Relate the quality and quantity of these flows to the overall effectiveness of the units studied.

Develop techniques to diagnose and suggest means of improving problems in personnel, logistics, and training management activities as they relate to overall unit effectiveness.

Units included in the sample were selected to meet the requirement of a broadened base (combat, combat support, combat service support), subject to availability during the study timeframe. In Forces Command, data were collected from 14 active duty battalions during the period 24 March through 28 August 1980; in the Reserves, from sixteen battalions, three brigade headquarters, and one division headquarters from the 100th Division (TNG), but not reported here; and in USAREUR, the entire 3d Armored Division from 23 June through 27 September 1980. The actual number of active Army respondents was 5170: 676 officers, 1186 noncommissioned officers, and 3308 E4 and below.

In addition to reaffirming the findings from the initial research, this research revealed the Living Systems Process Analysis (LSPA) technique can distinguish, analytically, among battalions of different effectiveness. It also demonstrated that all battalions focus more on the information processes than on the materiel/resources ones and that some of the information processes are more strongly related to unit effectiveness than others. This last point holds true for the materiel/resources processes too, but to a lesser degree; and, as might be expected, the point is more clearly demonstrated within the area of logistics. Further, the effectiveness of a unit was shown to be related to the distinctive differences in the distribution of time and effort expended by unit members in performing the LS processes. Specifically, these differences demonstrate a clear functional division of labor among those members.

Norms Study (MAY 1981 - DEC 1981) - Application of Living Systems Analysis to the Establishment of Process Norms in the U.S. Army - The purpose of this study was to provide information which can be used to evaluate a battalion's performance from a "process perspective" and to guide a battalion's efforts to improve this performance. The study focused on the establishment of norms for critical information and materiel/resources processes, on the presentation of normative tables, and on the development of remedial guidance to correct deviations from the norms.

Norms developed in the study are discussed from the point of view of several data bases. Particularly important are process performance and process time. Other data bases, however, are also examined briefly. The examination of process performance yields a model of effectiveness for each

area of specialization--training, personnel, and logistics. Each model contains a set of process variables critical to that area and to battalion effectiveness overall. The investigation of process time, both for the battalion as a whole and for key components within the battalion, provides additional, complementary evidence for these models.

In general, the findings reveal that each area of specialization has a unique cluster of process variables and that more and less effective battalions differ significantly in the performance of and in the time allocated to these processes. Training effectiveness results from the accuracy of the information used in monitoring and making decisions about training. Personnel effectiveness hinges on the timeliness with which information is brought into and circulated within the battalion and on the accuracy of this information as it is used to provide the many "customer services" associated with personnel administration. Logistical effectiveness arises from the timeliness with which information is circulated and used within the battalion.

The establishment of process norms, especially for those process variables critical to each area of specialization, permits the assessment of a battalion's basic processes and their relationship to battalion effectiveness. This assessment can be accomplished in a simple, straightforward manner by consulting the Normative Tables and Performance Indicator Scales presented in the study. The Tables and Scales, much like the specification in a technical manual, permit a battalion commander and his staff to determine what needs to be remediated and how this remediation may proceed. Suggestions for general approaches to remediation in each area of specialization are also provided.

Battalion Systems Analysis Package (BSAP) - From the Normative Data Base was developed the BSAP, presently in a prototype stage of; it is a leadership augmentation device which permits a battalion commander and staff to evaluate the garrison battalion systemically in the areas of Personnel, Training, and Logistics. Not only is it diagnostic for problem identification, but it provides a means of gauging a battalion against other similar battalions in the Army through extensive use of Living Systems Process Norms. Furthermore, based upon the various combinations and levels of variables, it provides pointers toward established remedies located in various Army publications. Unit commanders have the option to concentrate on "problems" which may be preventing the battalion from achieving desired performance as well to permit "fine tuning" for those wishing to improve already acceptable performance.

#### Implications-Descriptive Utility

The concepts of Living Systems (LS) were understood by virtually everyone who responded to the interviews and questionnaires. The concepts seemed to make sense, almost intuitively, to unit personnel and, indeed, seemed to offer personnel a useful perspective by which to view their own tasks within the battalion. It has also been shown that an Army battalion can be described as a living system--that is, as an organization containing the materiel/resources and information processes critical to any system.

In addition, Living Systems Process Analysis (LSPA) concepts distinguish among battalions in much the same way as do the traditional measures of unit

effectiveness. At the same time, LSPA reveals much more about the internal dynamics of the units than would traditional measures.

Of particular importance, LSPA concepts provide a means to analyze a critical aspect of unit effectiveness--information processing. From both a theoretical and a practical point of view, information processing is the core of unit effectiveness. The information coming into and being sent out of the unit constitutes a major connection with the Army as a whole. The information processed within the unit is the major ingredient in managing the tasks of the unit, whether these tasks are principally materiel/resources or information. The critical nature of information processing is especially clear when questions about the diagnostic utility of Living Systems Process Analysis are examined.

### Diagnostic Utility of LSPA

It is of course important to demonstrate that LSPA concepts can be used to describe battalions and, more particularly, information processing within these battalions. A more crucial test of the approach, however, is its usefulness in identifying and analyzing problems. In this research, LSPA concepts have been used primarily to "diagnose" two kinds of problems--in the division of labor among components within battalions and in the "health" of these battalions.

LSPA and Component Analysis - It has been shown that LSPA concepts can be used to analyze the distribution of training, personnel, and logistics management costs (i.e., time and effort) across components in a battalion and the distribution of these costs for each component across information processes. This analysis suggests that LSPA can be used to diagnose potential sources of problems in an organization's division of labor by examining the distribution of tasks among position holders and the distribution of each position holder's time and effort devoted to processes necessary to accomplish these tasks. Such a diagnosis might serve to promote a more effective coordination of activities and components.

LSPA and "Health" Analysis - It has also been shown that LSPA can be used to analyze battalions, processes, and management activities in terms of their "health." LSPA can be used to monitor the health of an organization on a regular basis. Such monitoring permits both the constant evaluation of organizational effectiveness and the assessment of planned change.

### Further Implications

The findings of the research demonstrate the utility of Living Systems Process Analysis as a descriptive and diagnostic tool. Clearly, these concepts provide a means to analyze the battalions as organizations. But what specific practical conclusions about Army management can be drawn from this research? In order to address this question, it is useful to posit some tentative conclusions from the research and to speculate on some of the implications of these conclusions for Army management. These hypotheses will be presented in the order in which the research findings have been presented.

The Utility of a Process Perspective - The data collection revealed that the approach to organizational analysis implied in Living Systems Theory had, for Army personnel, a "make-sense" quality. Army personnel seemed, almost intuitively, to understand the concepts and reported that these concepts seemed to have immediate relevance for their own grasp of the functioning of Army units. With regard to the relevance of the Living Systems Process Analysis, both as an approach to research and as a means to managing Army units, several tentative hypotheses are suggested.

1. The greater the process perspective which Army personnel are capable of taking, the greater their ability to manage Army units effectively. This conclusion of course requires careful consideration. It establishes a chain of relationships between the character of an individual's attitudes and abilities and the unit's effectiveness.

It is clear that the Army unit, like any organization, is in part understandable in terms of its processes. Thus, it is reasonable to conclude that, all other things being equal, those who understand these organizational processes are better able to manage the tasks of an organization. Furthermore, if Army personnel appreciate their own jobs in the context of the whole unit (and Army), they are likely to be more efficient in processing information because they will grasp the meaning and criticality of these jobs. Clearly, a practical understanding of organizational processes may be promoted through conscious, deliberate training of Army personnel in process analysis.

2. The greater the process perspective Army personnel are capable, the greater their ability to evaluate effectively. This conclusion is of course contained within the first conclusion but is being dealt with separately because it merits special attention.

It seems reasonable to assume that more effective techniques of evaluation are in part a function of increased understanding of process analysis. More specifically, an understanding of process analysis can be used to "dissect" the functioning of a complex organization. The goals of an Army unit, for example, can be depicted as the culmination of a series of processes carried out by diverse components. Incomplete or inefficient realization of an Army unit's goals may reflect a failure to carry out adequately certain identifiable processes critical to these goals. For example, inadequate or incomplete realization of training goals may be explained in terms of such specific factors as an insufficient amount of meaningful information being processed within a battalion as regards the training of trainers.

3. The greater the unit personnel's appreciation of and skills in information processing, the greater the effectiveness of the unit. Information processing is critical to the overall effective functioning of the unit and increased appreciation of and skills in this processing will lead directly to improved unit effectiveness.

Process Analysis - The analysis of battalion information processing revealed that the process variables (meaning, volume, cost, lag, and distortion) were associated, in varying degrees, with unit effectiveness, with training, personnel, and logistical management activities, and with information subsystems. Several hypotheses may be derived from these results.



4. The more efficiently accomplished are the variables affecting the information processing within the unit, the greater the unit effectiveness. The traditional measures of unit effectiveness do not directly assess the variables affecting information. Yet, this research has shown that these sets of variables (meaning, volume, cost, lag, and distortion) are repeatedly associated with unit effectiveness.

5. Regular measurement of the variables affecting information processing within the unit can be used to monitor unit effectiveness. A statement of the obvious often suggests new perspectives. In this instance, the fact that these process variables are so closely associated with unit effectiveness measures means that process variables can be used as surrogate measures of effectiveness and thus reveal more about the internal functioning of the unit.

Recurrent assessment of these process variables, carried out by unit personnel themselves as part of regular day-to-day operations, will provide a constant check on unit effectiveness. (See the discussion of the Battalion Systems Analysis Package - BSAP.)

Component Analysis - An analysis of the ways in which the components of the units allocate their time among the different information and materiel/resources processes provided a number of interesting findings. The hypotheses which can be drawn from the component analysis do offer insights into the ways in which unit personnel spend their time in information and materiel/resources processing relative to training, personnel, and logistical management.

6. The more the specialization of function among unit personnel is based on a process analysis of the unit, the greater the unit effectiveness. Clearly, any division of labor within an Army unit must respond both to the needs of the unit and to the capacity of the personnel within that unit. One way in which to relate unit needs and personnel capacity is to identify the processes critical to the unit's meeting its goals and the components best able to carry out these processes. A process-based division of labor will not necessarily differ significantly from traditional Army prescriptions of labor specialization. In both instances, the emphasis would be upon ensuring as fully as possible that critical tasks are undertaken by those best able to accomplish them.

But a process analysis of specialization of function provides a means by which to relate the processes entailed by unit activities to processes carried out by unit personnel. Analyzing this relationship permits both a more precise description of the unit's division of labor and a diagnosis of sources of dysfunction within this division. For example, the research revealed that commanders of more effective battalions devoted a large part of their duty days to making decisions (Deciding) and to monitoring the activities of the unit (Monitoring). Commanders in less effective battalions, while carrying out these processes to a lesser extent, devoted a good deal of time to recommending change (Relating) and to approving and sending information out from the unit (Outputting). That is, in less effective battalions, commanders seem to be bogged down in paper work perhaps best left to other components of the unit. A similar dysfunction appears at the company level, where company

commanders in more effective battalions spend greater time in deciding and monitoring than do their counterparts in less effective battalions.

7. The more frequently activities are carried out by components more able to carry them out, the greater the unit effectiveness. This is, of course, an obvious conclusion. But it takes on special meaning in the context of process analysis. Different components of a unit are trained to carry out different processes to some extent. Thus, battalion commanders are presumably more able to make unit-wide complex decisions than are assistant operations NCOs. If the individual trained to carry out the process fails to do so, someone less qualified will assume the task if the unit is to continue. It has been seen, for example, that, in less effective battalions, battalion executive officers take on a large role in training management, perhaps because battalion and company commanders are not carrying out these activities sufficiently. But executive officers are not prepared in these areas. Likely, then, training suffers, as does the overall effectiveness of the unit.

One must of course be cautious in interpreting these findings because too great a standardization of function may ultimately be counterproductive. That is, while the division of labor in more effective battalions can be described and compared with that in less effective battalions, it does not necessarily follow that these differences are the cause of differences in effectiveness.

Indeed, the lack of effectiveness might itself be the cause of the differences in division of labor. For example, ordering executive officers in less effective battalions to get out of training management will not guarantee improved unit effectiveness--nor, for that matter, improved training management. Executive officers may well be engaged in training by default; that is, others are not devoting sufficient attention to these activities. Removing the executive officer might in fact exacerbate the situation.

There is an additional danger in overstandardizing the division of labor. Specialization of function is of course intended to promote efficiency. Someone who knows his job well, and what precisely it entails, is presumably more likely to perform efficiently. And efficiency is presumed to be related to combat readiness and effectiveness.

But combat effectiveness also seems to entail some degree of cohesiveness. To be effective in combat seems to require some combination of efficiency and solidarity. Overspecialization could in fact threaten unit solidarity by creating rigid lines of demarcation among unit components.

8. The smoother and more interrelated the flow of information among components, the greater the unit effectiveness. Even if specialization of function is process-based and each component is carrying out those processes he/she is best qualified to handle, unit effectiveness will still suffer if information flows are irregular and uncoordinated. That is, the efficiency of information processing depends in part on how smoothly information flows among components and on how coordinated this information flow is.

For example, in more effective units, battalion commanders, S-3s, and company commanders seem to form an "information team." Among the three positions all the information processes necessary for training management receive attention.

Of course, each position, as would be expected, devotes a good deal of time to making decisions and monitoring the unit; S-3s spend much of their time bringing information into the unit, transmitting information within the unit, and translating information for use within the unit. Together, the three positions accomplish many of the processes necessary for training management and appear to do so in a coordinated fashion. This coordination would seem to maintain among these positions a flow of information necessary for unit effectiveness.

9. The less time the Battalion Commander devotes to the daily routine management of battalion operations, the more effective the unit. This hypothesis is based on the time utilization of the commanders of the high effective battalions. These battalion commanders foster decentralized decision making and delegate most functions to the appropriate staff sections. They then are free to spend more time on the internal monitoring of the unit activities and on communicating their plans to their command. Once the plans are made, the decisions and supervision are turned over to the staff with the commander monitoring their performance.

In the less effective battalions the commander is usually more involved in the routine staff function with highly centralized decision making. This greatly restricts his available time and leads to a situation where he/she is unable to monitor the unit's functions effectively and to use this information in planning.

10. The more time and effort the battalion commander devotes to monitoring and supervising the unit, the more effective the unit. As mentioned above, the commanders of the high effective units spend more time monitoring the ongoing activities. Perhaps the old saying that people do those things well that the boss checks is true. The commanders of the effective units spend nearly 2 1/2 times more effort in this area than do the commanders of the less effective units. An additional benefit of this practice is the fact that their company commanders adopt the same habits and thus also spend about the same amount of time monitoring their unit activities.

11. The more relevant and timely the information provided the battalion commander for planning and decision making, the more effective the unit. Failure to receive pertinent information hampers the commander. This is found in the less effective battalions where the commanders spend an additional 5% of their total time trying to obtain information. This difficulty in obtaining timely information is again demonstrated in the additional time required to plan and reach a decision. The commanders of the effective battalions spend on the average 10.5% of their time on planning and decision making while the commanders of low effective units spend 35.7%. The 20% of time gained in the three processes allows the well informed commander to concentrate on other areas that make the unit more effective.

A factor that contributes to an imbalance of time expenditure is the poor utilization of the battalion staff. The commanders of the high effectiveness units allow their staffs to make many routine decisions under their supervision while the commanders of the less effective units often make many of the decisions within their units.

12. The more freely information flows within the chain of command, the more effective the battalion. In order for the unit to function, information must be available and passed on. The commanders of the high effective battalions, assisted by the Command Sergeant Major, spend over 8% of their available time insuring that information flows freely in the unit. In the less effective units, where the commanders spend less time on the information flow, other unit members have to spend additional time on this process and thus have less time for their functions.

Information flow in the high effective battalions also involves the Senior NCOs. The Command Sergeant Major, as mentioned above, the Battalion Operations Sergeant, and the First Sergeant are more involved in this process than are their counterparts in the less effective units. The unit cannot be effective if the members of the unit lack the required information for the desired action. Only a free flow of information can assure that the system is responsive to the needs.

13. The more time company commanders spend monitoring and developing information to create action in a unit, the more effective the unit. In the high effective battalions the company commanders spend over twice the time monitoring their units that their counterparts in the low effective units spend. As a result of the commanders' action, the leadership at the platoon level in the effective units also spend more time monitoring their units. In the more effective units, from the battalion commander to the section chief, intensive monitoring seems to be a trait.

14. The more the S-3 delegates the inputting of information to the S-3 NCOs, the more effective the unit. The availability of training information from the outside sources is an important factor in the efficient operation of the battalion. This is recognized and the more effective battalions spend more time on this effort. Yet, it is not only the amount of effort that is important, but the personnel employed to gain this information. Instead of restricting the available time of the S-3 and the S-3 Air, the efficient S-3 delegates most of this function to his Operations Sergeant and the Assistant Operations Sergeant. Between these two NCOs in the high effective battalion there is a far greater expenditure of time, 3 times as much, as by the NCOs in the low effective units. A greater emphasis on the inputting process is also found in the S-2 section of the highly efficient battalion.

15. The more time the S-3 NCOs spend on the storage and retrieval of information, the more effective the unit. The ability to recall past information is an important function that assists the commander and his staff. In the high efficient units this seems to be one of the prime responsibilities of the NCOs assigned to the S-3 section. They spend twice as much time on this function as do their counterparts in the lower rated battalions. This is a continuation of the NCO involvement in the information processes in the more efficient battalions. The less efficient units fail to use the NCOs to such an extent in the information processes and let them spend more effort on the materiel/resources processes.

## FUTURE APPLICATIONS

It is clear from the preceding discussion that the research offers a number of insights into the operations of Army battalions and that these insights might provide useful ways by which to evaluate the effectiveness of Army units. Thus, the stress has been on the role of Living Systems Process Analysis as a means by which to monitor Army units. But this is certainly not the only possible application of the process analysis. Therefore, discussed below are several areas of further applications of potential value to the Army.

### Battalion Systems Analysis Package (BSAP)

From the Normative Data Base, a prototype leadership augmentation device, the BSAP, is being developed. This supplementary analysis tool will enable the battalion commander and his staff to evaluate the battalion systemically in the areas of training, personnel and logistics. It will serve as a diagnostic tool for problem identification, provide pointers to remedies for the problems and enable the commander to gauge his battalion's ability to process information and materiel/resources against the ability of other similar battalions in the Army.

The further development of this prototype device can be accomplished using information provided by units engaged in field training. This will allow developers better to understand relationships between the garrison and the field processing of information and materiel/resources and to reengineer the device accordingly. In this way, a systemic approach to battalion level management, from problem identification through remediation for both garrison and field experiences, can be realized.

### Living Systems Process Analysis in Simulated Combat Environments (LSPA-Field)

The utility of LSPA for units in garrison has been demonstrated by the past research. An expansion of the analytical approach will result in an innovative systems analysis of units engaged in a simulated combat environment, e.g., ARTEPS or the NTC.

The processing of information and materiel/resources can be analyzed, via LSPA, as the unit transitions from garrison to the simulated battlefield and in the simulated battlefield. The goal of the enhancement of the analysis process is to allow the commander better to predict his unit's battle performance, both simulated and actual, while in garrison.

### Command and Control (C<sup>2</sup>)

In order to conduct simulated combat operations efficiently, the unit commander must be able to identify those essential elements of information related to the activities of Command and Control. Through further expansion the LSPA approach, a descriptive analytical device can be developed and correlations of performance to the quantified processing of information (and

materiel/resources) can be established, thus allowing the commander to evaluate the C<sup>2</sup> activities as they relate to the performance of his battalion.

### Modeling

The current family of stochastic combat models do not accurately represent the human dimension in the decision-making processes and the actual capabilities of the combatants. The development of stand-alone modules which incorporate the findings of previous living system based research, i.e., the translation of the C<sup>2</sup> and LSPA-Field findings into standard engineering formulas, will more accurately portray the human interactions in these simulations; thus making the simulations more representative of the situation the modeler is trying to describe. An additional bonus to the modeling effort will be the incorporation of normative data from an actual unit, as opposed to a hypothetical unit, allowing the commander to gain possible insights into the unit's ability to engage in combat.

### Living Systems Based Course of Instruction (COI)

The efficient processing of information and materiel/resources has proven to be a paramount indicator of more effective battalions. If the leadership at all echelons of a battalion were educated in the interrelationships of living systems processes and the development and maintenance of the units readiness posture, the leaders would be better able to take advantage of the tools and techniques needed for complex organizational management.

The course of instruction would increase the leaders' capability to manage materiel, personnel, money, and information, thus increasing the effectiveness of their units. The level of sophistication of the COI would be compatible with the input competence and leadership potential of the participants.

### Reconceptualizing the U.S. Army Organization Using a Living Systems Approach

The traditional hierarchical structure of the U.S. Army often hinders the timely and accurate flow of information through the communications conduits. The variables leading to misinformation or lack of information are all present in these arduous channels of the current organization. Interference, lag, and distortion have to be minimized or eliminated if one wants an efficient information network.

Reconceptualizing the organizational structure of the Army in terms of a systems approach will allow the decision makers to gain insights into the system's pathologies. The critical processes as defined in LST should form the basis for the analysis, and the reconceptualization should encompass the precepts of systems theory.

Figure 1

## SEVEN LEVELS OF LIVING SYSTEMS

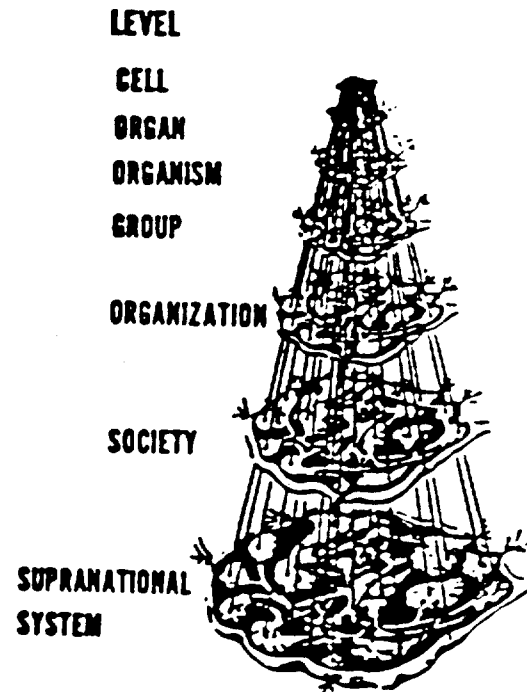


Figure 2

## INPUTS, THROUGHPUTS, AND OUTPUTS

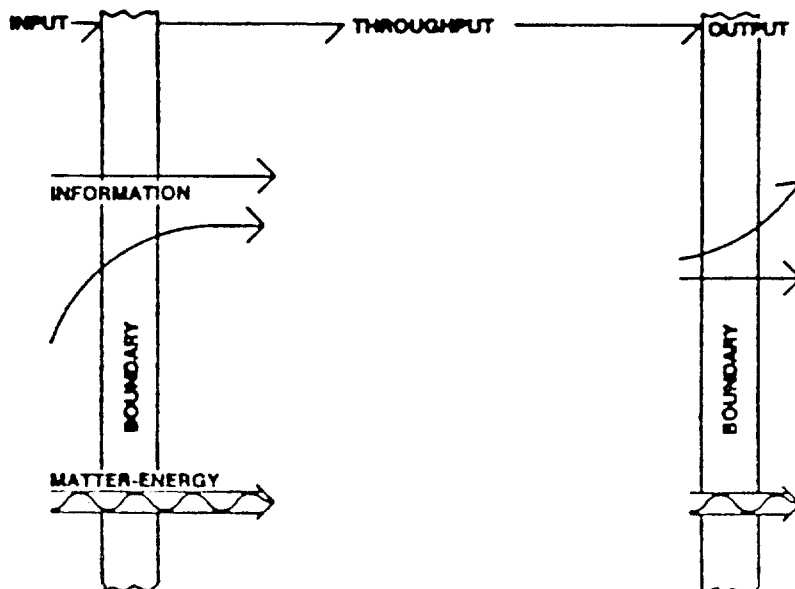


Figure 3

## 19 CRITICAL PROCESSES

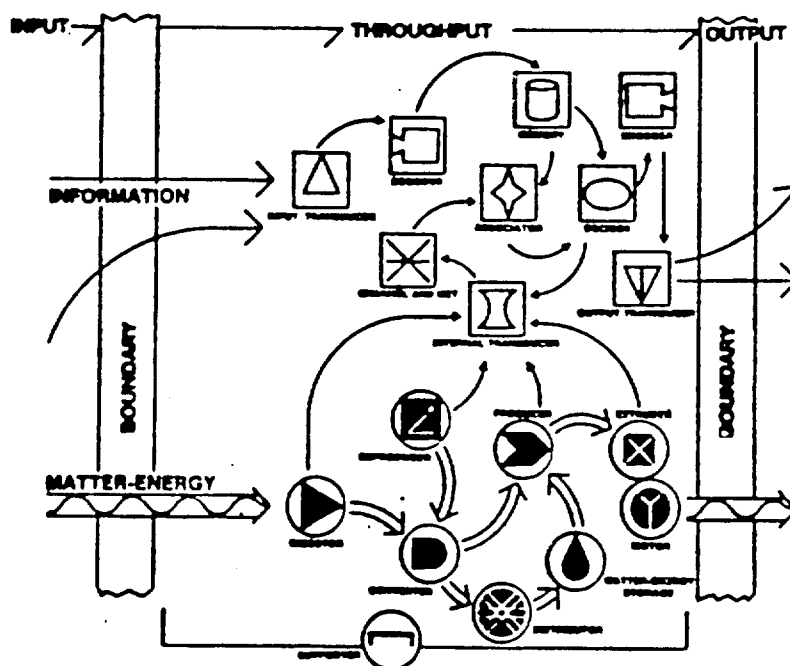


Figure 4

## ARMOR BATTALION TASK FORCE AND TRAINS

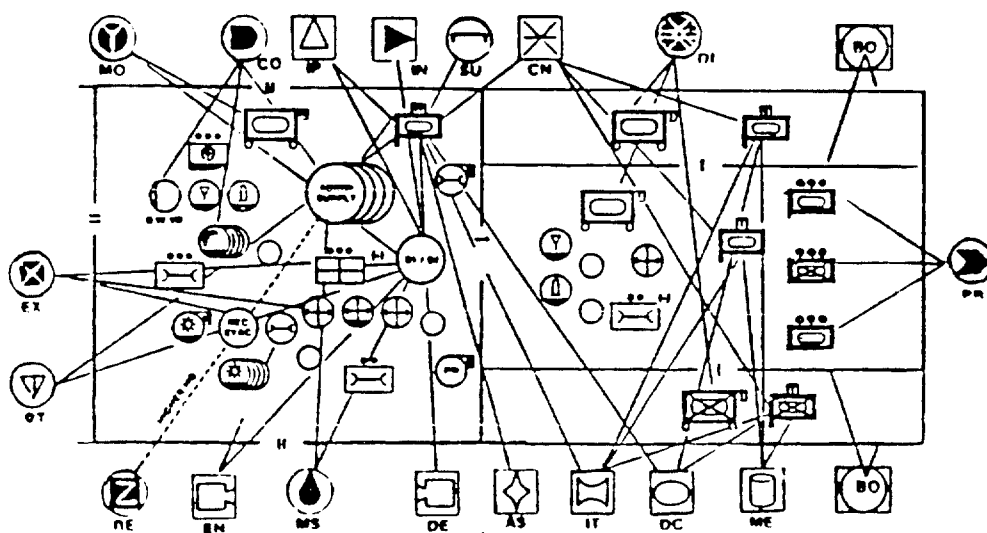




Figure 5

SYSTEM PERFORMANCE: LAG IN PROCESSING TNG MGT INFO

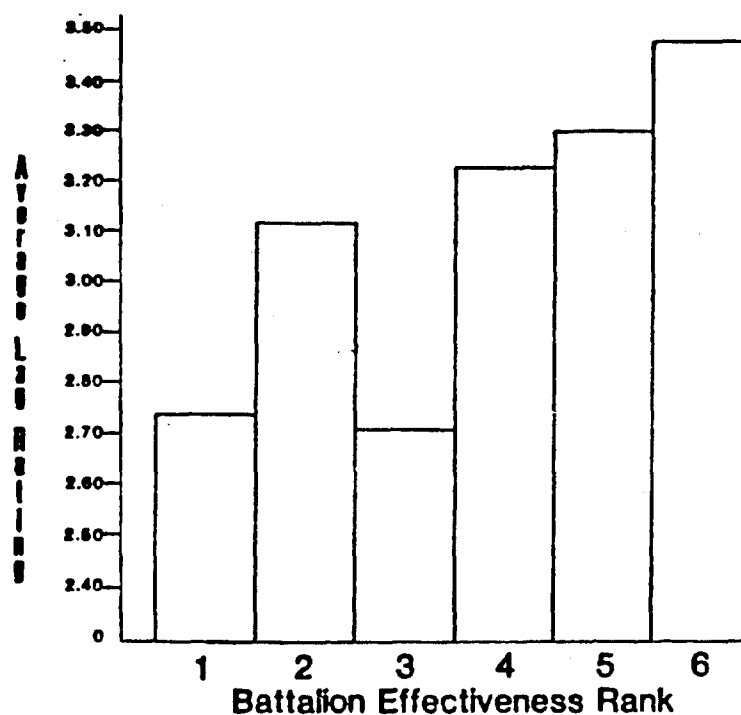


Figure 6

SYSTEM PERFORMANCE: INFORMATION LAG - TNG MGT ACTIVITIES

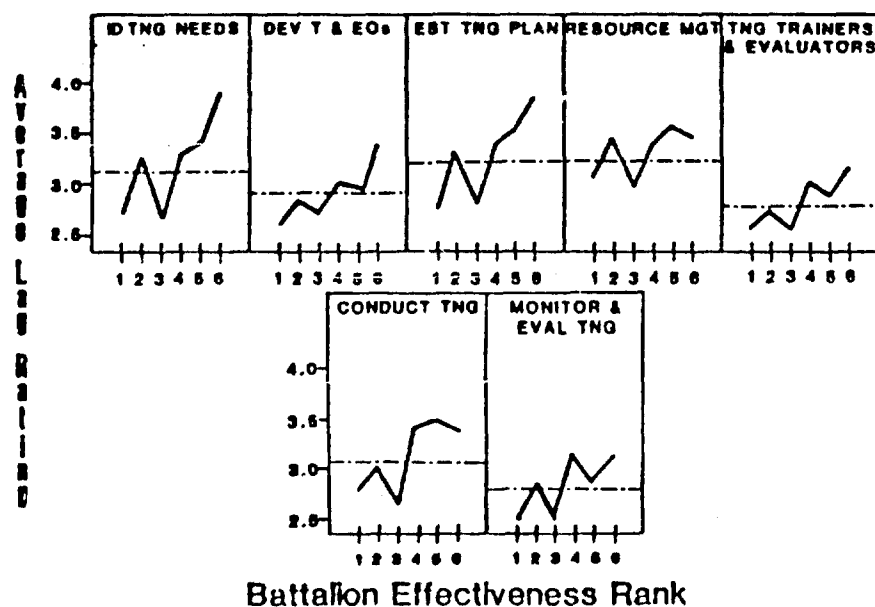


Figure 7

SYSTEM PERFORMANCE: LAG IN PROCESSING TNG MGT INFO

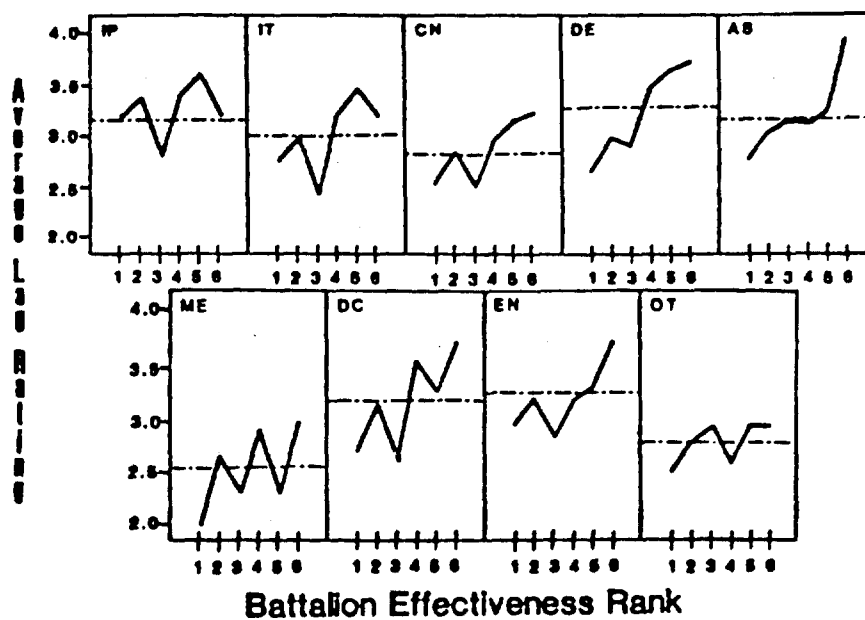


Figure 8

SYSTEM PERFORMANCE: DISTORTION IN PROCESSING TNG MGT INFO

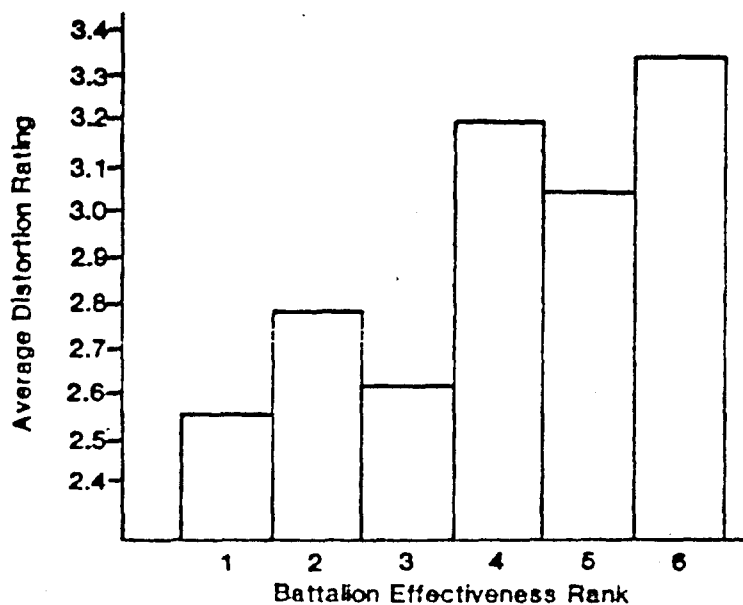


Figure 9

SYSTEM PERFORMANCE: COST IN PROCESSING TNG MGT INFO

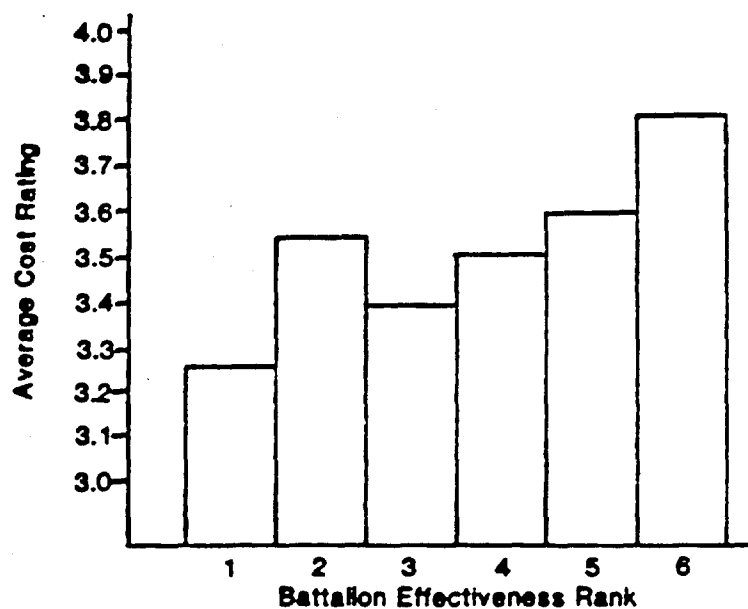


Figure 10

SYSTEM PERFORMANCE: COST OF PROCESSING TNG MGT INFO

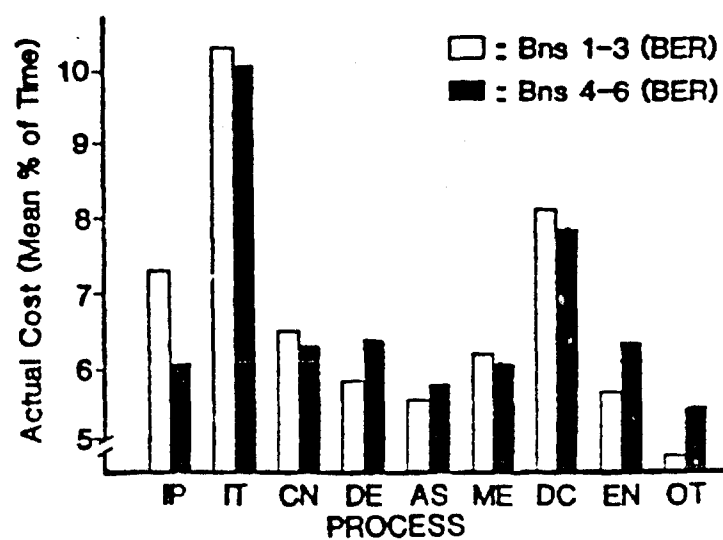


Figure 11

SYSTEM PERFORMANCE: PERCEPTIONS OF PROCESS EFFICIENCY

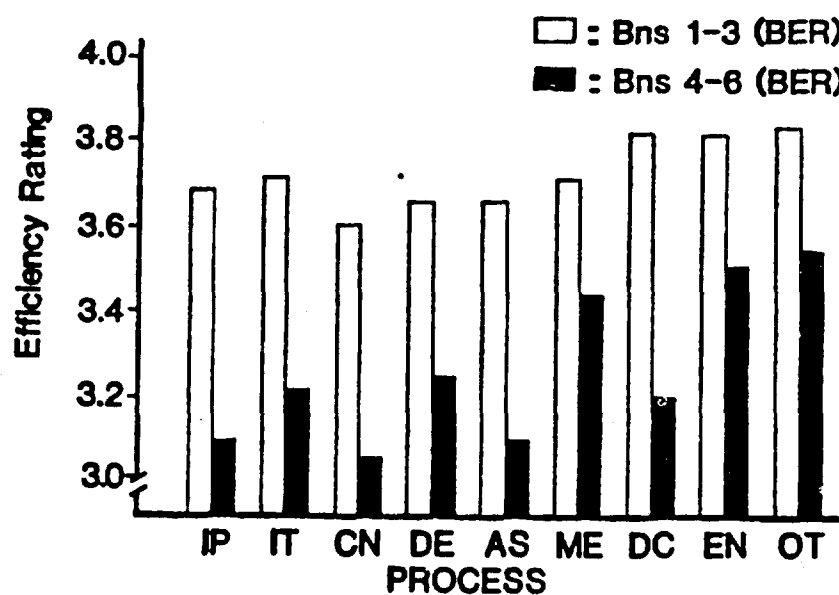


Figure 12

SYSTEM PERFORMANCE: TOTAL COST OF PROCESSING TNG MGT INFO BY COMPONENT

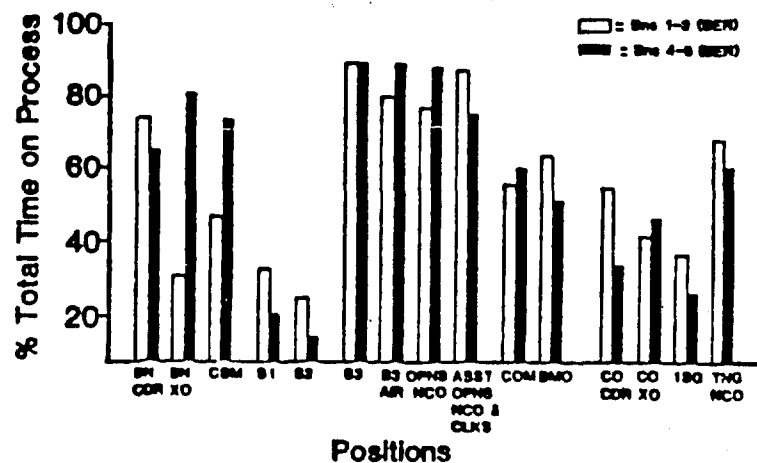


Figure 13

## SYSTEM PERFORMANCE: SUBSYSTEM COST BY COMPONENT

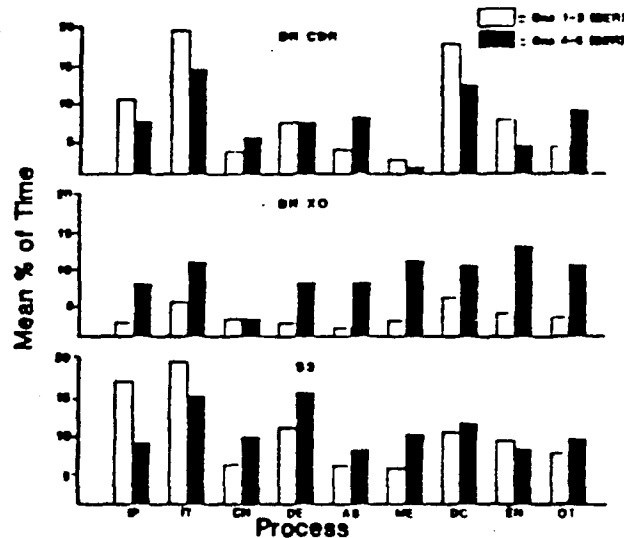


Figure 14

## GENERAL FINDINGS

1. LIVING SYSTEMS THEORY CONCEPTS ARE UNDERSTANDABLE TO MILITARY PERSONNEL.
2. ARMY UNITS CAN BE DESCRIBED AS A LIVING SYSTEM.
3. LIVING SYSTEMS THEORY PROCESS ANALYSIS HAS DEMONSTRATED REAL POTENTIAL FOR DISTINGUISHING AMONG BATTALIONS IN TERMS OF EFFECTIVENESS.
  - A. LIVING SYSTEMS THEORY DISTINGUISHES AMONG BATTALIONS IN TERMS OF EFFECTIVENESS ON 3 VARIABLES: LAQ, DISTORTION, AND COST.
  - B. TRAINING MANAGEMENT ACTIVITIES DATA FURTHER SUPPORT THE RELATIONSHIPS BETWEEN THE VARIABLES AND EFFECTIVENESS.
  - C. SPECIFIC PROCESS DATA ALSO DELINEATE THESE RELATIONSHIPS.
  - D. RESPONDENT'S PERCEPTIONS OF PROCESS EFFICIENCY FURTHER DISTINGUISH AMONG BATTALIONS.
4. WITHIN BATTALIONS, EFFECTIVENESS APPEARS TO BE RELATED TO THE DISTRIBUTION OF TIME AND EFFORT (COST) ACROSS POSITIONS.
5. THE HEALTH OF PROCESSES HAS BEEN TENTATIVELY DESCRIBED IN TERMS OF LIVING SYSTEMS VARIABLES.



Figure 17

## BREAKOUT OF DATA SAMPLE RESPONDENTS

	OFFICERS	NCOs	ENLISTED (E-4 & BELOW)	TOTAL
FORSCOM	301	694	1141	2136
USAREUR	375	492	2167	3034
TOTAL	676	1186	3308	5170

Figure 18

## BATTALION EFFECTIVENESS RANKS (BERs)

PERFORMANCE  
INDICATORS

% REQUIRED EQUIPMENT READY  
 % SQT GO  
 % CBR QUALIFIED  
 % .45 QUALIFIED  
 % RIFLE QUALIFIED  
 % PT QUALIFIED  
 % TEAM QUALIFICATION GO

COMMAND  
INDICATORS

% RE-UP QUOTA - 1ST TERM  
     - CAREER  
 ♦ ADVERSE PERSONNEL ACTIONS  
 % STRENGTH - OFFICER  
     - ENLISTED  
 % MOS TRAINED  
 % GRADE SHORTAGE - OFFICER  
     - SENIOR NCO  
 % MONTHLY TURNOVER  
 TRAINING FACTOR AVAILABILITY

## PERCEPTIONS

SOLDIERS  
 SQUAD, CREW OR SECTION  
     LEADERS  
 PLATOON LEADERS, PLATOON  
     SERGEANTS  
 CSM, 1SG  
 BN CDR & STAFF, CO CDR  
     & STAFF  
 BDE CDR & STAFF

Figure 19

## PROCESS PERCEPTION DATA

- **STATE** (EVALUATION OF EACH INFORMATION & MATERIEL/RESOURCES PROCESS)
- **TIME** (% TIME IN EACH INFORMATION OR MATERIEL/RESOURCE PROCESS)
- **IMPORTANCE** (RANK OF EACH INFORMATION & MATERIEL /RESOURCE PROCESS)
- **PERFORMANCE** (USEFULNESS, ACCURACY, TIMELINESS, COST, VOLUME OF EACH INFORMATION & MATERIEL/RESOURCES PROCESS)

Figure 20

## PROCESS OBJECTIVE DATA

## EXAMPLES

## TRAINING

PUBLICATIONS ORDERED  
 REQUIRED CHANGES POSTED  
 OBSOLETE PUBLICATIONS

## PERSONNEL

MILPO/SIDPERS TRANSACTIONS  
 INTER-BATTALION AND POSITION NUMBER REASSIGNMENTS  
 QUARTERLY 'CHAPTER' SEPERATIONS

## LOGISTICS

REPORTS OF SURVEY/INVENTORY ADJUSTMENT REQUESTS  
 GOVERNMENT PROPERTY LOST OR DAMAGED  
 VEHICLES OPERATIONAL



Figure 21

PROCESS OBJECTIVE DATA / PROCESS PERCEPTION DATA RELATIONSHIPS

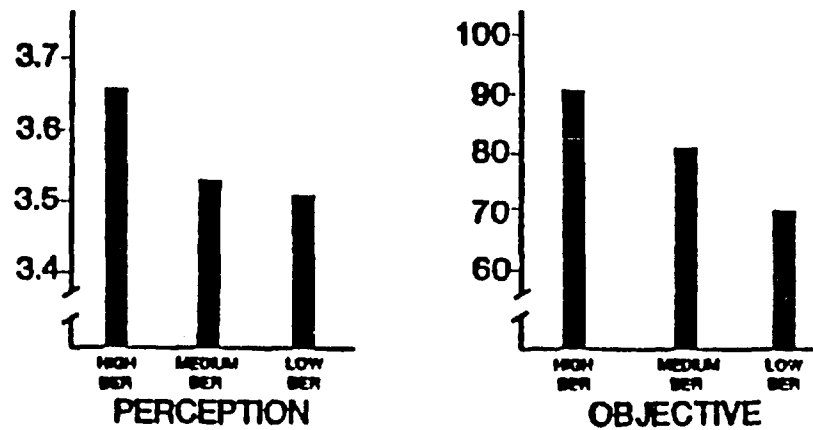


Figure 22

DATA MATRIX

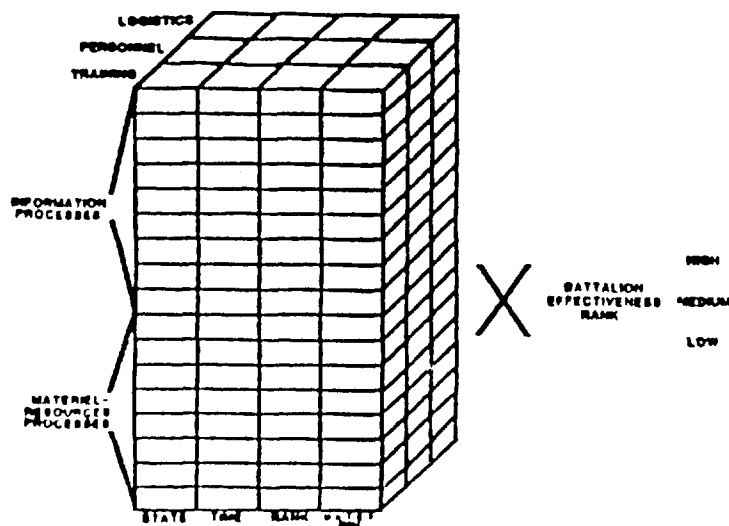


Figure 23

## TRAINING MANAGEMENT INFORMATION / ARMOR BATTALIONS

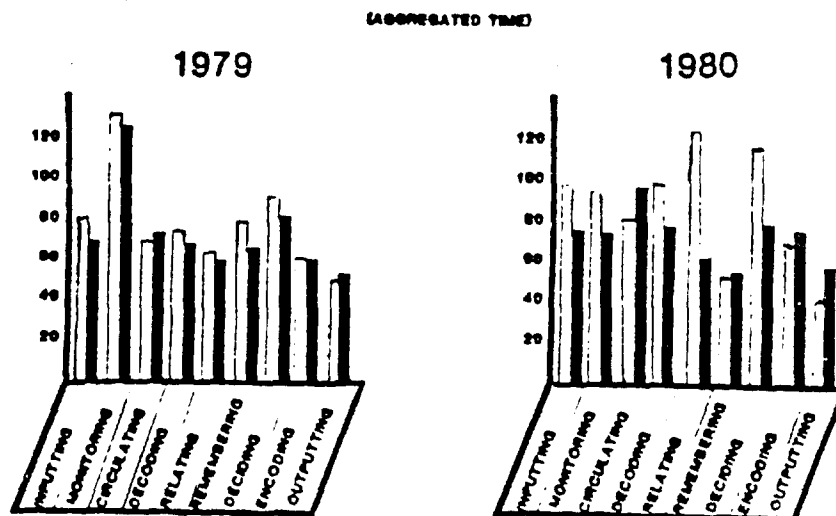


Figure 24

## PERCENTAGE OF TOTAL DUTY TIME IN PERSONNEL

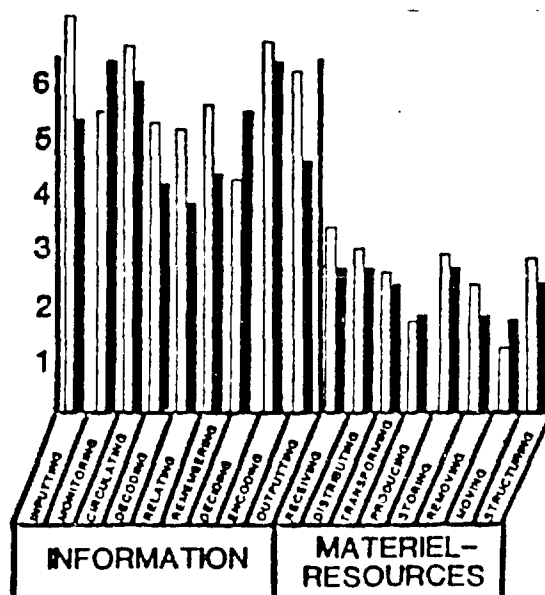


Figure 25

## PERCENTAGE OF TOTAL DUTY TIME IN LOGISTICS

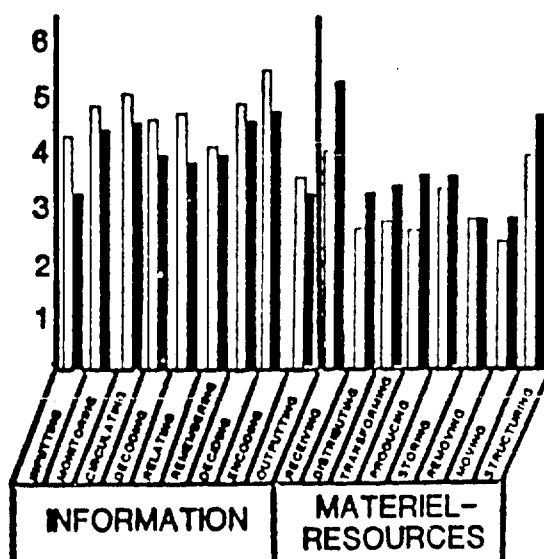


Figure 26

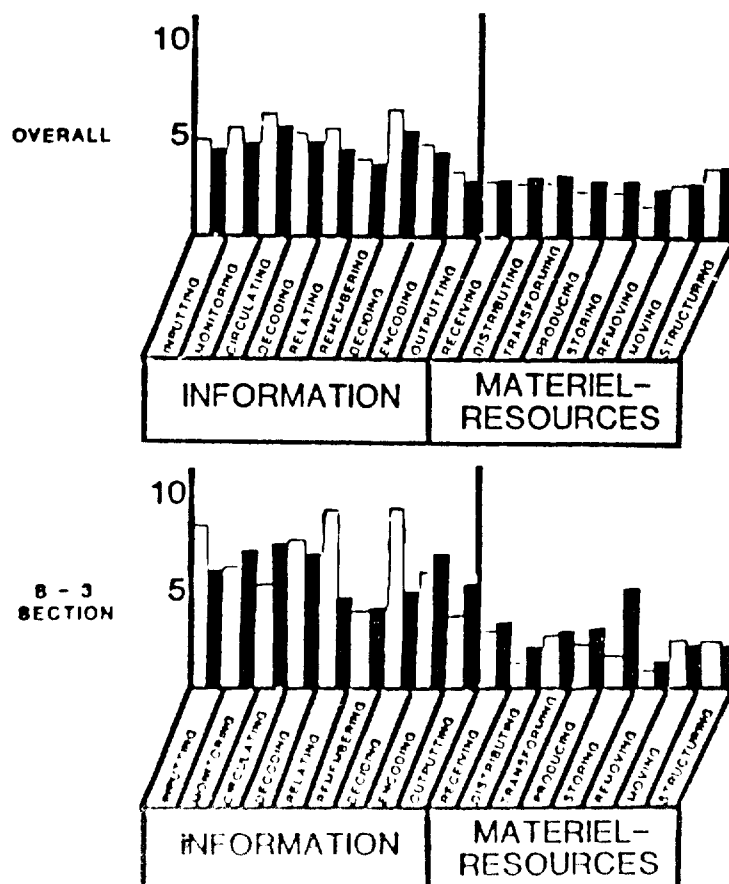
PERCENTAGE OF TOTAL DUTY TIME IN TRAINING -  
OVERALL AND S-3 SECTION

Figure 27

PERCENTAGE OF TOTAL DUTY TIME IN TRAINING -  
BN CDRs, S-3 SECTIONS AND CO CDRs

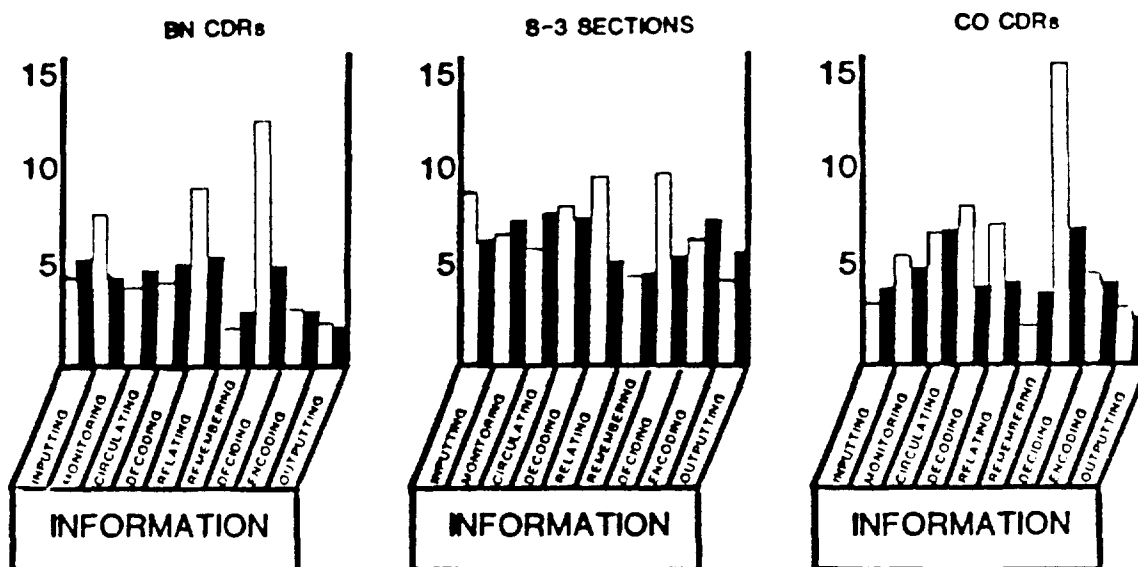


Figure 28

PERCENTAGE OF TOTAL DUTY TIME IN TRAINING -  
S-3 SECTION BY COMPONENT

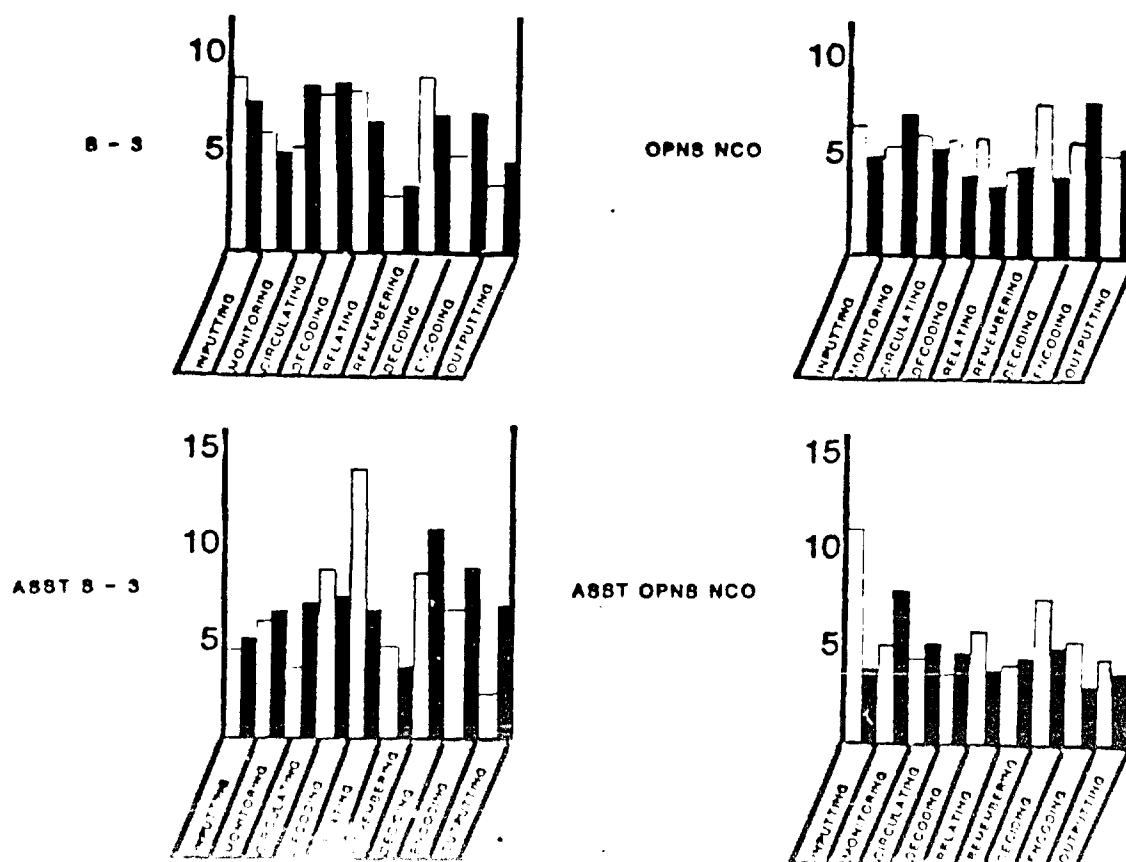


Figure 29

PERCENTAGE OF TOTAL DUTY TIME IN TRAINING -  
INFORMATION INPUTTING AND CIRCULATING

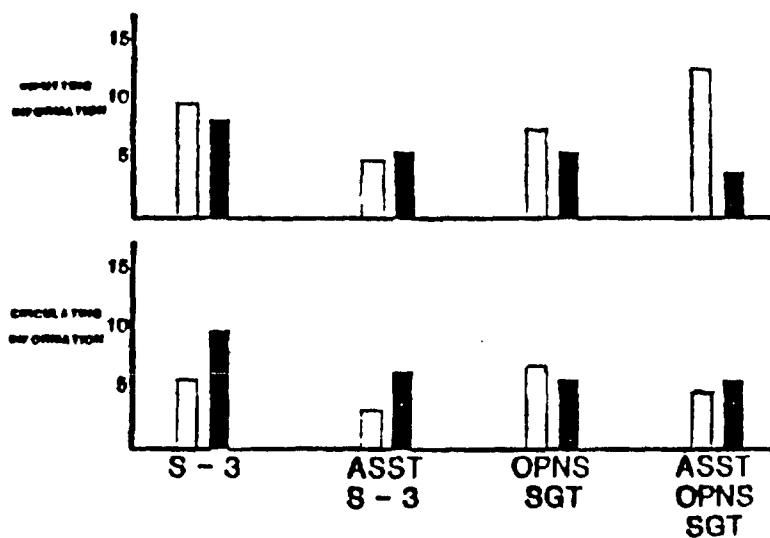


Figure 30

TRAINING PERFORMANCE AND BATTALION EFFECTIVENESS:  
MAJOR PROCESSES

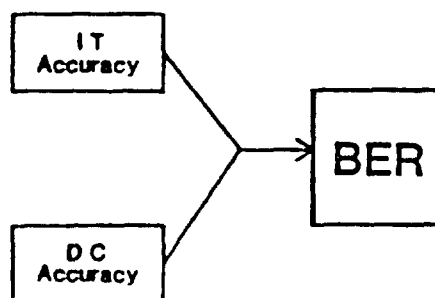


Figure 31

TRAINING PERFORMANCE AND BATTALION EFFECTIVENESS:  
CONTRIBUTING PROCESS

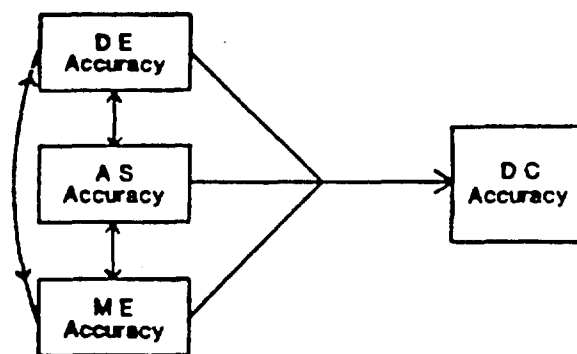


Figure 32

TRAINING PERFORMANCE AND BATTALION EFFECTIVENESS:  
COMPLETE TRAINING MODEL

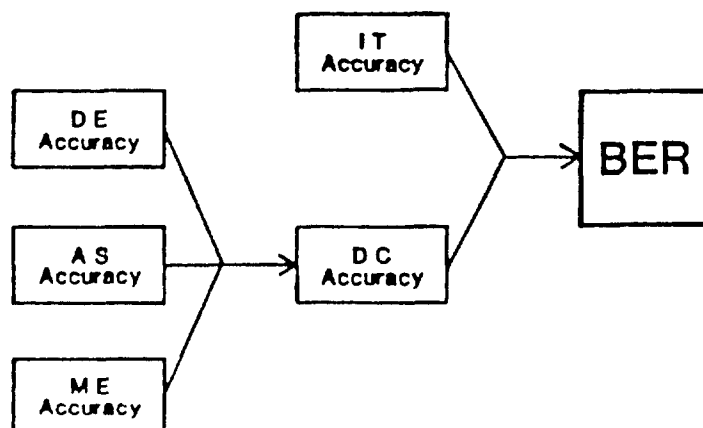


Figure 33

PERFORMANCE INDICATOR SCALE:  
SAMPLE

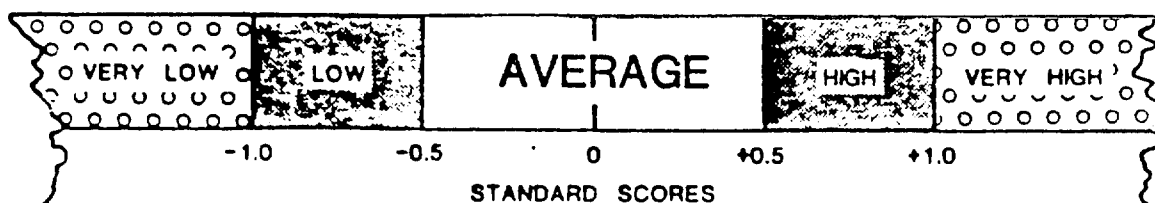


Figure 34

PERFORMANCE INDICATOR SCALE:  
IT ACCURACY IN TRAINING

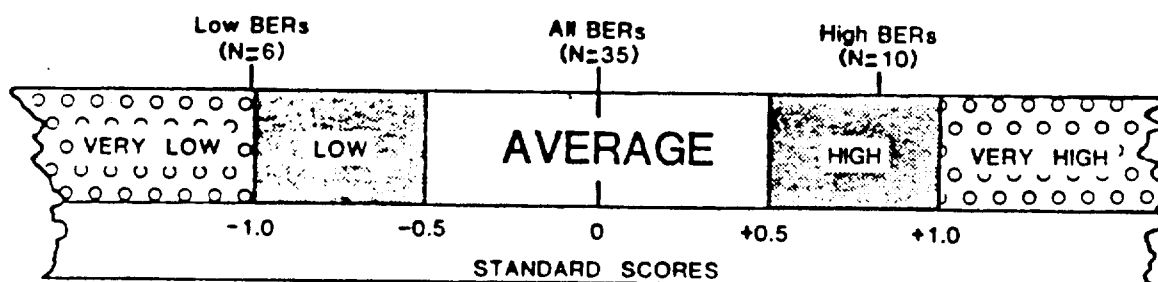
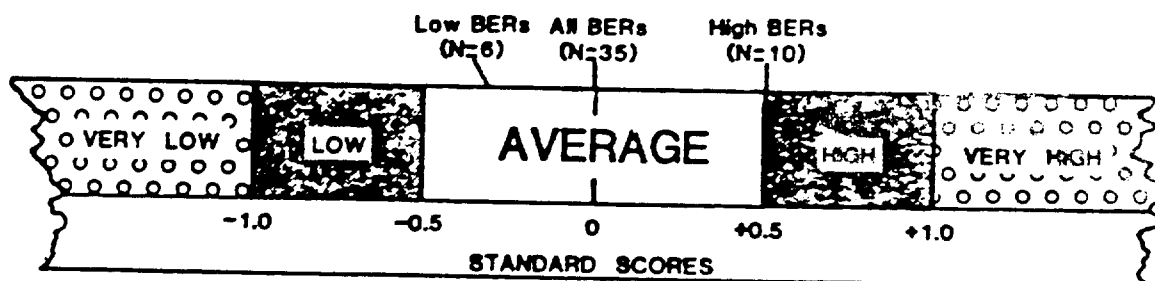


Figure 35

PERFORMANCE INDICATOR SCALE:  
IT TIME IN TRAINING





## BIBLIOGRAPHY

- Burnside, Billy L. Tank Crews and Platoons as Living Systems. U.S. Army Research Institute Working Paper FKFU 80-2, Fort Knox Field Unit, Fort Knox, KY, November 1979.
- Cary, MAJ James S. "A Cybernetic Feedback Subsystem for Training Control" in Military Review, Vol. LXI, No. 6, June 1981.
- Cary, James S. "Memorandum, Subject: Living Systems Research Orientation," for USAREUR Research Personnel, 9 June 1980.
- Cary, MAJ James S. Approaching the Unapproachable: Application of Living Systems Theory (LST) at the Department of Defense Level. Task Force Delta Concept Paper, No. 5.12, TRADOC Systems Doctrine Office, Fort Monroe, VA, April 1980.
- Cary, James S.; and Ruscoe, Gordon C. Application of Living Systems Theory to United States Army Battalions: An Executive Summary. Systems Science Institute, University of Louisville, Louisville, KY, December 1981.
- Cary, James S.; Ruscoe, Gordon C.; et al. "Application of Living Systems Process Analysis to the U.S. Army Battalion." Report presented to Chief of Staff Army, et al., January 1981.
- (Cary, James S.; Ruscoe, Gordon C.; et al.) Application of Living Systems Theory to the Evaluation of Critical Processes in the Armor Battalion: An Exploratory Analysis. Systems Science Institute, University of Louisville, Louisville, KY; U.S. Army Training and Doctrine Command, Systems Doctrine Office, Fort Monroe, VA, August 1979.
- Cary, James S.; et al. "Memorandum, Subject: Living Systems Research and Development." Presented to Chief of Staff, US Army Training and Doctrine Command, Fort Monroe, VA, 8 May 1981.
- Malone, COL Dandridge M. X=H. Task Force Delta Concept Paper, TRADOC Systems Doctrine Office, Fort Monroe, VA, January 1980.
- Merker, Steven L.; and Ruscoe, Gordon C. (eds.). Application of Living Systems Theory Process Analysis to Critical Activities of the US Army Battalions: Personnel and Logistics. Technical Report, U.S. Army Research Institute, Alexandria, VA, September 1981.
- Miller, James Grier. Living Systems. McGraw-Hill Book Company Inc: New York, NY, 1978.
- Miller, James Grier. "Living Systems: Basic Concepts" in Behavioral Science, Vol. 10, No. 3, July 1965.
- Peter, Lorena R.; and Ruscoe, Gordon C. (eds.). A Living Systems Theory Analysis of Army Battalions Impacted by the Battalion Training Management System. Final Report, U.S. Army Training Board, Fort Eustis, VA, April 1981.

Reed, Robert W.; Fell, Robert L.; and Sturm, Mark. "Modeling." (Class Paper for SYS 618, Systems Science Institute, University of Louisville, Louisville, KY), 30 April 1981.

Reed, Robert W. "A Living Systems Process Analysis of the 3d Armored Division." Report Presented to CG, 3d Armored Division, FRG, January 1981.

Ruscoe, Gordon C. Application of Living Systems Analysis to the Establishment of Process Norms in the United States Army. Final Report, U.S. Army Training Support Center, Fort Eustis, VA, December 1981.

Ruscoe, Gordon C. Performance Norms for the U.S. Army: A Preliminary Analysis. Systems Science Institute, University of Louisville, Louisville, KY, November 1981.

Ruscoe, Gordon C.; Giguet (Peter), Lorena R.; Brown, Bill R.; et al. Application of Living Systems Theory to the Evaluation of Critical Processes in the Armor Battalion: An Exploratory Analysis. Technical Report, U.S. Army Research Institute, Alexandria, VA, December 1979.

Ruscoe, Gordon C.; et al. Interim Report: The Impact of the Battalion Training Management System on 13 FORSCOM Battalions. Report, U.S. Army Training Board, Fort Eustis, VA, December 1980.

Ruscoe, Gordon C.; et al. Living Systems Analysis of Army Battalions Impacted by Battalion Training Management System: A Sample Report. A Paper presented at Delta Force Meeting, Carlisle Barracks, PA, 7 September 1980.

Witt, LTC William W. Information Engineering. Task Force Delta Concept Paper, TRADOC Systems Doctrine Office, Fort Monroe, VA, May 1980.

(Witt, LTC William W.) A Report on the Application of Living Systems Theory to U.S. Army Armor Battalions. TRADOC Systems Doctrine Office, Fort Monroe, VA, November 1979.